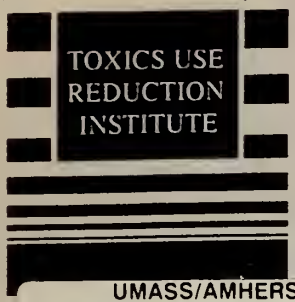

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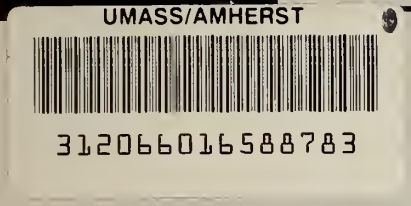

IN-DEPTH INVESTIGATION OF TOXICS USE REDUCTION IN MASSACHUSETTS INDUSTRY

Methods and Policy Report No. 16 **1997**

University of Massachusetts Lowell

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In-Depth Investigation of Toxics Use Reduction in Massachusetts Industry

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The Toxics Use Reduction Institute is a multi-disciplinary research, education, and policy center established by the Massachusetts Toxics Use Reduction Act of 1989. The Institute sponsors and conducts research, organizes education and training programs, and provides technical support to promote the reduction in the use of toxic chemicals or the generation of toxic chemical byproducts in industry and commerce. Further information can be obtained by writing the Toxics Use Reduction Institute, University of Massachusetts Lowell, One University Avenue, Lowell, Massachusetts 01854.

Notice

This study was funded by the Toxics Use Reduction Institute under contract number S963489 to Greiner Environmental. This report has been reviewed by the Institute and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Toxics Use Reduction Institute, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

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1. Executive Summary

1.1. Background

The Massachusetts Toxics Use Reduction Act (TURA - MGL 21), passed in 1989, sought to establish toxics use reduction (TUR) as the primary strategy for managing toxic chemicals in the Commonwealth. The Act was structured to build the capacity of Massachusetts businesses to implement TUR projects through training, education, research, and technical assistance. TURA does not require Massachusetts facilities to implement toxics use reduction projects, nor does it require that facilities meet specific reduction goals. Instead TURA establishes a framework for businesses to analyze their operations. These analyses are meant to uncover TUR opportunities that not only reduce risks to the environment, consumers, and workers, but also contribute to the business bottom line.

Roughly six-hundred Massachusetts facilities are subject to the Act's requirements. These firms have ten or more full time employees, are included in Standard Industrial Classification (SIC) codes 10-14, 20-40, 44-51, 72,73, 75, and 76, and manufacture, process, or otherwise use TURA listed chemicals over certain thresholds. Firms that comply with the Act must:

- file annual Form S reports that detail toxic chemical use and byproduct generation; and
- prepare a TUR plan that must be updated every two years and be certified by a licensed TUR Planner.

Three types of services are funded by the Act to support its implementation: Technical Assistance, Education and Training, and Regulatory Outreach, Compliance and Enforcement.

- Confidential technical assistance is provided by the Office of Technical Assistance (OTA). Technical assistance includes evaluating and recommending TUR technologies, helping firms to comply with environmental regulations, and working with small businesses required to prepare Form S reports and TUR plans.
- Training and education services are provided by the Toxics Use Reduction Institute (TURI). These services include the delivery of training for TUR planners as well as the administration of a state-wide continuing education TUR program. TURI also conducts TUR research through academic, laboratory, and industry grant programs.
- Regulatory outreach, compliance and enforcement are provided by the Department of Environmental Protection (DEP). These services include compliance assistance, data management, development of reporting and planning regulations, compliance monitoring, and compliance enforcement. The Act also requires DEP to develop and implement guidelines and regulations on inspections that emphasize TUR and are multimedia in nature.

1.2. Methodology

This investigation sought to understand whether TURA motivated businesses to implement toxics use reduction measures, over and above what otherwise would have been implemented at the site. Data was collected to meet the following three study goals:

- To deepen understanding of whether and how firms in Massachusetts have implemented TUR;

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- To assess the impact of the major components of the TURA program (e.g., reporting, planning, technical assistance, education and training, and regulatory outreach, compliance, and enforcement) on firm's environmental management practices; environmental compliance performance; competitive position; materials accounting practices; worker health and safety performance; etc.; and
- To contribute to an assessment of the costs and benefits of the TURA program.

Twenty-five firms were chosen to participate in the study using a stratified random sampling strategy. In-person interviews at each facility ranged from forty-five minutes to four and one half hours and averaged two hours. Persons outside a firm who were significantly involved in the company's TUR activities were also interviewed. The facility's TURA data, 1994 plan, 1996 plan update (if available), and technical assistance report were examined during the interview.

1.3. Extent of Toxics Use Reduction Activity

Based on an analysis of the TURA data and augmented by qualitative interviews, it appears that each of the 25 investigation firms implemented one or more toxics use reduction changes between 1990 and 1996. A TURA data analysis of 22 firms that filed Form S reports between 1990 and 1994, showed that the average and median normalized byproduct reduction per company per year was 80,143 lb. and 19,240 lb. respectively. The average and median normalized use reduction per company per year was 94,648 lb. and 11,749 lb. respectively. Sample toxics use reduction projects included:

- the reduction of 23,000 lb. per year of copper ammoniate solution at an electronics manufacturer by modification of the process.
- the substitution with a mild surfactant for highly concentrated (73%) sodium hydroxide powder in a food cleaning operation that eliminated 14,000 lb. per year; and
- the installation of a nitric acid recovery system by a job shop metal finishing company. The project eliminated roughly 2,000 lb. of nitric acid use and byproduct generation;

During each interview, respondents were asked what motivated their company to make toxics use reduction changes. Firms cited both non-TURA and TURA factors. Predominate non-TURA factors included the Clean Air Act, good business sense or saving money, plant safety, and reduced compliance. Predominate TURA factors included reporting, planning, technical assistance, and education and training. Eighty percent of the LQTUs in the investigation (18 of 22) indicated that one or more of these TURA factors led them to implement TUR over and above what otherwise would have been implemented at the site. The three SQTUs in the investigation, each of which received technical assistance, stated that such assistance lead them to implement TUR over and above what otherwise would have been implemented at the site.

1.4. Form S Reporting

In roughly one-third (six of nineteen) of the interviews, respondents claimed that Form S reporting was beneficial to their company. In these cases, preparing Form S reports led to better information on the flow of materials through the facility, composition of products, efficiency of production processes, and the volume of company waste streams. Thirteen firms failed to see any internal benefit from preparing their Form S reports.

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Detailed information was also collected on the cost of preparing Form S reports over and above those costs associated with preparing EPCRA Form R reports. For first-time Form S reporters, the average reporting costs per facility averaged $1,813 per year[1]. Second-time reporting costs per facility averaged $1,276 per year.

1.5. TUR Planning

The findings indicate that TUR planning was one of the strongest forces motivating reductions in toxic chemical use and byproduct generation. Of 21 firms that prepared plans, 11 firms stated that planning was a major factor in prompting the company to not only consider but also implement TUR projects beyond that which would have occurred without the Act. Planning was a supporting factor in the TUR efforts of four additional firms. The preparation of TUR plans led to no TUR implementation at six firms.

Complete or partial accounting of project savings were quantified for 12 companies. Only those projects implemented *as a result of preparing the TUR plan* were included in the analysis. Project benefits for three firms were not quantifiable owing to a lack of data. Project savings were summarized with a discounted cash flow analysis using an escalation factor of 5%, discount rate of 12% and ten year project life-time. Savings range from $776,965 to ($15,163). Project savings for all 21 1994 plans totaled $1,513,420 and averaged $72,068.

Detailed information was collected on the cost of preparing 1994 TUR plans and 1996 TUR plan updates. The average cost per 1994 TUR plan was calculated to be $16,248. The median 1994 plan cost was $5,867. Plan costs ranged from as much as $150,000 to less than $1,000. The average cost per 1996 TUR plan update was calculated to be $10,414. The median plan update cost was $ 3,129.

TUR investment data was also compiled on the 1994 TUR plan. Three of 21 firms quantified capital investments made as a result of planning. These investments ranged from $8,960 to $173,690. One firm in the study was unable to provide information while 17 firms reported no capital investments. Capital investments totaled $208,206 and averaged $9,915.

The depreciation effects of the three firms that reported capital investment were calculated using a ten-year straight-line depreciation method. These depreciation benefits were then adjusted to 1995 dollars using a discount rate of 12%. Tax effects were calculated using a 40% tax rate. Depreciation and tax effects ranged from $9,856 to ($93,853) and averaged ($14,584).

To examine the net financial impact of the 1994 TUR plans, Greiner Environmental calculated the plan net present value (NPV). The NPV is equivalent to the savings from all plan projects minus plan preparation costs, project investment costs, and depreciation and tax effects. The plan NPVs ranged from as high as $359,284 to as low as ($14,785) and averaged $33,440. The median plan NPV was calculated to by ($702). Since the financial data was analyzed in 1995

[1]All cost and benefit data in this report has been adjusted to 1995 dollars to conform with the methodology used by Abt Associates, Inc. in the *Benefit-Cost Analysis of the Massachusetts Toxics Use Reduction Act.*

dollars, the individual firm results can be added together and averaged. Table 1-1 presents the total results and the average results for 21 firms.

Table 1-1 Total and Average Financial Results

	Plan NPV	Project Savings	Preparation Costs	Investment Costs	Depreciation and Tax Effects
TOTAL	$702,240	$1,513,420	($320,704)	($208,206)	($306,270)
Average	$33,440	$72,068	($16,248)	($9,915)	($14,584)

TUR planning also led to reductions in annual toxic chemical use of 342,680 lb. and annual toxic chemical byproduct generation of. 326,471 lb. Respondents claimed planning led to qualitative benefits in areas such as:

- Improved Product Quality: While preparing its TUR plan, a medium sized heat treating firm found that a key process chemical (ammonia) was poorly controlled in the process. The lack of control led not only to excessive ammonia use, but also poor product quality. Installing flow control valves improved product quality by lowering product rework and scrap.
- Valuable Process Knowledge: A job shop metal finishing firm claimed to use its 1994 TUR plan to move to a newly constructed building. The plan contained information on process operations, product flow, and materials use and byproduct generation rates. It was used to design a new process layout and to size new process and treatment equipment.
- Worker Health and Safety: The planning process at a plastic extruding firm led the company to enclose its raw material mixing area were powders (such as zinc oxide) are blended. Enclosing the area led to a major reduction in worker exposure to respirable powder particles.

1.6. Technical Assistance, Education and Training, and Regulatory Services

The Act establishes three services to aid Massachusetts industry in their toxics use reduction efforts: Technical Assistance, Education and Training, and Regulatory Outreach, Compliance, and Enforcement.

Technical Assistance services appear to have been effective in both reducing environmental hazards and providing a return on investment to several of the firms that used the service. Eleven firms in the investigation received technical assistance in the form of on-site reviews of their industrial operations. These reviews led to recommendations and to the ultimate implementation of TUR projects at four firms. At the time of this study, three firms were in the process of testing their technical assistance recommendations. These implemented projects reduced the use and waste generation of materials such as zinc, sulfuric acid, xylene, and water. Technical assistance financial benefits were quantified for three firms. As a result of the technical assistance recommendations, the three companies realized project savings of $1,106,851. These firms made capital investments of ($32,720). Depreciation and tax effects totaled ($117,652). The TUR projects implemented at these three companies as a result of technical assistance, resulted in a net present value $856,479. In all 11 cases, technical assistance services met or exceeded company expectations in terms of the quality of recommendations, the depth and detail of research, and the timeliness of assistance delivery.

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From the results of the interviews with 11 TUR planners, the TUR planners course significantly improved the preparation of TUR plans. The course taught planners basic materials accounting, process analysis, and option identification skills that led to the ultimate implementation of TUR projects. Firms whose planners took the course tended to prepare plans that resulted in TUR implementation more frequently than those that did not take the course. While satisfied on the whole with the course and the continuing education requirements, respondents recommended changes to the flow of the planner's course and to TUR continuing education offerings.

The Act defines certain regulatory outreach, compliance, and enforcement responsibilities to support TUR activities in the Commonwealth. On the whole, respondents were pleased with the regulatory outreach services such as the development of Form S and planning guidance documents as well as the telephone assistance provided to firms by the Boston DEP TURA office. In the area of TUR compliance and enforcement, the Act requires the implementation of multimedia inspections and the integration of TUR principles into enforcement. Respondent opinions on multimedia regulatory compliance and enforcement services were mixed. Roughly half of the respondents approved of multimedia inspections -- primarily because the inspections conserved company resources by conducting multiple inspections during a single visit. But nearly an equal number noted that multimedia inspectors were insufficiently trained and that such inspections were easier than their single media counterparts. In addition, TUR strategies were not prominent in the multimedia inspections. Although based on a limited sample, it appears that the efficacy of multimedia inspections to promote TUR and basic compliance could be improved.

1.7. Conclusions

Based on the results of this investigation, the Act appears to be fulfilling its intended purpose of reducing toxic chemical use and byproduct generation. Eighty percent of the firms (21 of 25 companies), reported that one or more of TURA's five main components (reporting, planning, technical assistance, education and training, and regulatory compliance, outreach, and enforcement) played a major or supporting role in implementation of TUR changes.

The Act appears to have increased their awareness of toxics use reduction as an environmental management strategy. For example, firms, consultants, and vendors are more aware of cleaner production methods, tools for analyzing processes, and methods to better integrate environmental concerns with business concerns. The Act has also spurred a network of TUR professionals that provides valuable contacts and information.

While this in-depth investigation found that the Act appears to be working well on the whole, improvements in the following areas should be considered:

- Improve the Act's ability to measure TUR progress. While the annual Form S reports were helpful in determining the types of chemicals used at a facility as well as the firm's main processes, the byproduct reduction index cannot be used to pinpoint the TUR progress of a small group of facilities. Making TUR measurement simpler would enable industry, government, and the public to better understand TUR progress.

In-depth Investigation

- Review why financial analyses in TUR plans were either omitted or prepared in a rudimentary way. Slightly more than half of the plans reviewed included financial analyses. Of those firms that did a financial analysis, the analysis typically examined only obvious cost categories such as waste disposal and waste treatment. While complex financial analysis is not necessary in every case, better analyses may increase TUR project implementation.
- Better integrate TUR in regulatory compliance and enforcement services performed by regional offices. A greater emphasis on TUR in multimedia compliance inspections and in enforcement would focus Massachusetts industry on the value of toxics use reduction.

Finally, the TURA program should continue its emphasis on improving technical assistance, education and training, and regulatory outreach services. While meeting the current needs of firms in this study, continuous improvement of these services will build the capacity of Massachusetts business to meet the toxics use reduction challenges that lie ahead.

2. Background and Methodology

The Massachusetts Legislature enacted the 1989 Toxics Use Reduction Act (TURA - MGL Ch. 21I) to promote reduced use of toxic chemical use and byproduct generation in the Commonwealth. The Act establishes a goal of reducing toxic or hazardous byproduct generation by 50% from 1987 to 1997 through toxics use reduction (TUR) methods. Under TURA, toxics use reduction is defined as input substitution, product reformulation, production unit redesign or modification, production unit modernization, improved operation and maintenance, and recycling, reuse or the extended use of toxics[2]. TURA does not require Massachusetts facilities to implement toxics use reduction projects, nor does it require that facilities meet specific reduction goals. Instead, TURA establishes a framework for businesses to analyze business operations for TUR changes. When implemented, these TUR changes not only reduce risks to workers, consumers, and the environment, but also contribute to the bottom line.

Roughly six hundred Massachusetts facilities are subject to the Act's requirements. These firms have ten or more full time employees, are included in Standard Industrial Classification (SIC) codes 10-14, 20-40, 44-51, 72,73, 75, and 76, and manufacture, process, or otherwise use TURA listed chemicals over certain thresholds. TURA designates firms that must comply with the Act as large quantity toxics users (LQTUs). Firms that do not meet the employment, SIC code, or use thresholds do not have to meet TURA requirements. The Act defines such firms to be small quantity toxics users (SQTUs).

Large quantity toxics users must file annual Form S reports (detailing toxic chemical use and byproduct generation) and prepare a TUR plan. Plans must be updated every two years and be certified by a licensed TUR Planner. Certified TUR planners fall into two categories: limited practice planners and general practice planners. Limited practice planners are only licensed to certify their facility's plan. General practice planners must take a 48-hour course and pass an exam. General practice planners, who are frequently consultants, are licensed to certify any facility's plan.

Three organizations -- that together comprise the TURA Program -- are responsible for implementing and administering the Act: The Department of Environmental Protection (DEP), the Office of Technical Assistance (OTA), and The Toxics Use Reduction Institute (TURI). DEP's main responsibilities include TURA data management, developing Form S reporting and planning regulations, compliance monitoring, and compliance enforcement. The Act also requires DEP to develop and implement guidelines and regulations on inspections that are multimedia in nature (e.g. inspecting water, air, and hazardous waste media simultaneously) as well as use TUR in its compliance and enforcement activities.

OTA provides large and small quantity toxics users with confidential technical assistance. This includes assisting firms in preparing TUR plans, evaluating TUR technologies and complying

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[2] TUR is essentially a strict interpretation of pollution prevention. TURA covers certain chemicals and includes only in-process pollution prevention activities. Out-of-process recycling and waste treatment are not considered TUR.

with TURA and other statutes through site visits, workshops, and telephone assistance. TURI houses the research and education branch of the TURA Program. The Institute developed the toxics use reduction planner curriculum and administers a state-wide education program for TUR planners. Other Institute activities include TUR research through academic, laboratory, and industry grant programs.

This investigation examines toxics use reduction activities at 25 randomly selected Massachusetts businesses, most of whom are subject to the Act's requirements. The investigation was designed with three objectives in mind: (1) to deepen understanding of whether and how firms in Massachusetts have implemented TUR; (2) to assess the impact of specific components of the TURA program (e.g. planning, reporting, technical assistance, training, education, research) on a firm's environmental management practices, environmental compliance performance, competitive position, materials accounting practices, worker, health and safety performance, etc.; and (3) to contribute to an assessment of the costs and benefits of the TURA program.

2.1. Sample Selection

The investigation used a stratified random sampling strategy to select 25 companies. With the aid of the TURA Program, investigators designed a set of sampling targets. The targets included a minimum number of general and limited practice certified plans, a minimum number of facilities receiving a technical assistance site visit, a minimum number that had at one time complied with TURA but were no longer required to do so, and a minimum number of firms receiving multimedia inspections. These targets are outlined in Exhibit 2 below.

Table 2-1 Sample Performance Targets

A total of 25 firms comprised of:

- 5 LQTUs who's plans were certified by a limited practice planner;
- 5 LQTUs who's plans were certified by a general practice planner;
- 3 LQTUs that received technical assistance;
- 2 SQTUs that received technical assistance;
- 3 LQTUs that previously filed under TURA and prepared a plan but no longer file and are still in business (a.k.a. Former TURA Filers);
- 5 firms that received a multimedia inspection; and
- additional firms chosen at random from the 1994 list of TURA filers.

Note: a single firm may meet multiple criteria (for example received a multimedia inspection, had a technical assistance visit, and used a general practice planner.)

Firms using limited practice planners were randomly selected from a list of limited practice planners. Greiner Environmental telephoned each firm, detailed the nature of the study, and asked them to participate. If interested, an appointment was made for an in-person interview. If not interested, another firm was contacted. This process continued until five firms agreed to participate.

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Firms using general practice planners were chosen at random from a list of 1994 filers. Since no contact names for such firms were available, Greiner Environmental called the firm's main number and solicited the person in charge of TURA activities to participate in the study.

Since TURA provides confidentiality to all firms that use technical assistance services, site-visit firms could not be selected from publicly available information. Greiner Environmental worked out a selection methodology with the cooperation of OTA. Greiner Environmental randomly selected seven LQTUs and seven SQTUs. OTA contacted each firm and asked whether the firm wanted to participate in a confidential TURA and technical assistance evaluation. Six of the seven LQTUs agreed to participate. Four of the seven SQTUs agreed to participate. OTA forwarded the firm names and contact information. Greiner Environmental contacted the first three LQTUs and the first three SQTUs on the list and set up interview appointments.

One goal of the study was to examine TUR at firms that were no longer required to comply with TURA. To meet this goal, Greiner Environmental used an internal DEP report detailing the reasons why 43 firms had reported in 1993 but not in 1994[3]. The reasons for not reporting were varied (see Table 2.2). Firms whose use dropped below the 10,000 lb. reporting threshold were not interviewed. This category of firms no longer reported for business reasons (e.g. low demand for product requiring a TUR chemical) -- not because they had implemented TUR changes. Greiner Environmental and TURI staff decided that interviews of former TURA filers should focus on firms that had eliminated or reduced a chemical via TUR. Two randomly selected firms from the chemical elimination category were chosen to participate in the study.

Table 2-2 Former TURA Filers

Reason For Not Reporting	Number of Firms	Comments
Under Threshold	28	Use near the 10,000 lb. threshold but under for 1994
Chemical Eliminated	5	Chemical eliminated via TUR
Plant Shut Down	4	Moved or closed the manufacturing facility
Delisted Chemical	3	Chemical(s) delisted therefore reporting no longer required
Shut/sold Process	3	Moved or shut down process that used the chemical(s)

The multimedia sample performance target of 5 firms was easily met since DEP conducted multimedia inspections at more than 40% of LQTUs[4]. Given that 25 firms were to be interviewed, roughly 10 multimedia inspections (25 firms x 40%) were expected among the 25 interviews.

Up until this point, researchers had selected 18 firms to participate in the study: 5 firms using in-house planners; 5 firms using general practice planners; 3 SQTUs selected from technical assistance files; 2 LQTUs selected from technical assistance files, and 2 firms that are former TURA Filers. The remaining eight firms were chosen at random from 601 firms in 1994 TURA

[3] The report was prepared by Karen Levy of the DEP Bureau of Waste Prevention.

[4] There are 601 LQTU's in the 1994 TURA universe. DEP conducted 170 FIRST inspections at LQTU's in 1993 alone. Source: Massachusetts Administrative Council on Toxics Use Reduction. 1994 Annual Report.

database. Random selection methods similar to those outlined for general practice and limited practice TUR Planners were used. Information on the type of company and size of company is presented in Table 2-3.

Table 2-3 Demographic Information

Firm Description	LQTU	Planner Type	Technical Assistance	Multimedia Inspection	No. of Employees
Automotive Supplier	yes	limited		yes	480
Electronic Switch Maker		na	yes	yes	140
Job Shop Metal Finisher I	yes	general			40
Food Manufacturer I	yes	general			280
Food Manufacturer II	yes	general			300
Paper Converter I	yes	limited	yes	yes	170
Paper Converter II	yes	limited		yes	200
Paper Converter III	yes	na	yes		180
Membrane Manufacturer	yes	limited		yes	220
Heat Treater	yes	general			40
Electrical Components	yes	limited		yes	5500
Coatings Supplier	yes	general		yes	90
Gear Manufacturer	yes	general			170
Container Cleaning Firm	yes	general		yes	10
Job Shop Metal Finisher II	yes	general	yes	yes	110
Cable Manufacturer	yes	limited	yes	yes	200
Leather Processing Firm	yes	general	yes	yes	20
Metal Processor I	yes	limited			90
Metal Processor II		na	yes		180
Job Shop Painter	yes	general	yes	yes	60
Military Parts Producer	yes	limited	yes	yes	250
Plastic Extruder	yes	general	yes		100
Pump Manufacturer		na	yes		250
Job Shop Metal Finisher III	yes	limited		yes	30
Drum Reconditioner	yes	general		yes	20

2.2. Preparation of In-Depth Survey Instrument

In-person interviews were chosen for the investigation for their ability to collect detailed qualitative and quantitative data. The in-person interviews were targeted towards the person with primary responsibility for TUR reporting and planning activities at each firm. Telephone, mail, and fax survey instruments were not considered as data collection tools given the detailed and potentially sensitive information at issue. Focus groups were rejected also because of their tendency to provide general views as opposed to detailed, firm-specific information.

The draft survey was prepared with input from the TURA program staff. The survey included four sections (a copy of final survey is located in Appendix A). Section one covered background information on the firm and the respondent. Section two examined to TUR Form S

reports, 1994 TUR plans, and the 1996 TUR plan update. Section three was designed to collect project-specific cost/benefit information. Respondents were asked to fill out section three questions and fax the information back. Section four questions reviewed the efficacy of technical assistance, education and training, and regulatory outreach, compliance, and enforcement services.

2.3. Additional data sources

Researchers also collected Form S data and regulatory compliance data on each firm. Collecting this data in advance of the in-person interview served two functions. The TURA data helped to understand the number, identity, and purpose of TURA chemical use and byproducts at the facility before visiting the company. The regulatory compliance data indicated whether the firm had a multimedia inspection, a recent enforcement action, or a recent TURA inspection. This information was useful since some firms had difficulty recalling the date and nature of previous compliance inspections.

2.4. Pretest and Revisions

To set up the pretest, Greiner Environmental contacted two firms selected at random from the list of limited practice TURA planners. Greiner Environmental explained the purpose of the study, the study's sponsor (the Commonwealth of Massachusetts) and asked if the firm was interested in participating. Both pre-test firms agreed to participate. In-person interviews at the first were conducted with the primary planner and her supervisor. Two environmental, health, and safety persons were interviewed at the second firm. A brief write-up of pretest results are presented below in Table 2-4.

Table 2-4 Pretest Results

Positive Results	Negative Results
The instrument was useful for achieving the three investigation goals.	The instrument took too long to go through -- two and one half to three and one half hours per firm. It needed to be streamlined.
The instrument flowed well -- questions moved from less specific introductory questions to more specific TURA program evaluation questions.	Interviewees did not have cost/benefit data readily available.
Most of the information, except for project specific cost/benefit data) was readily at hand.	The data sheets were confusing to interviewees. The sheets were generic -- not tailored to the specific cost/benefit data needs for each firm.

As a result of the pretest, Greiner Environmental made three changes to the survey instrument. First, the introductory part of the interview was streamlined to cut roughly thirty minutes off the interview. Second, Greiner Environmental designed a fax letter to be sent in advance of the interview. The letter asked the respondent to have specific types of cost/benefit information available at the meeting as well as a copy of the firm's TUR plan (See Appendix B for a sample pre-interview letter). Third, rather than leaving generic data sheets behind with each firm, Greiner Environmental tailored post interview letters containing a list of unanswered questions and/or cost/benefit data needs. The follow-up letter was faxed to the respondent and accompanied by a follow-up phone call (see Appendix B for a sample post-interview letter).

2.5. Administration of In-Depth Surveys

To meet the 25 firm goal, Greiner Environmental contacted 39 firms. Fourteen firms did not participate in the study for the following reasons: five did not return phone calls, three were not interested, three were too busy, two had a company policy against surveys, and one facility had ceased operations. Table 2-5 below summarizes these results.

Table 2-5 Target Population Summary

Target Population	No. Target Firms	No. in Target Population	No. Firms Contacted to Meet Target	Comments
General Practice Plan Certification	5	249	6	1994 TURA database
Limited Practice Plan Certification	5	332	10	1994 TURA database
OTA LQTU Site Visit	3	244	4	Selected from internal technical assistance database
OTA SQTU Site Visit	2	136	4	Selected from internal technical assistance database
Former TURA Filers	2	5	4	Of those eliminating a chemical
Remaining Firms	8	585	12	1994 TURA database
TOTAL	25	NA	39	

Since a single firm could meet multiple criteria (for example received a multimedia inspection, had a technical assistance site visit, and used a general practice planner), the sampling targets for each population were easily met (see Table 2-6).

Table 2-6 Sample Performance

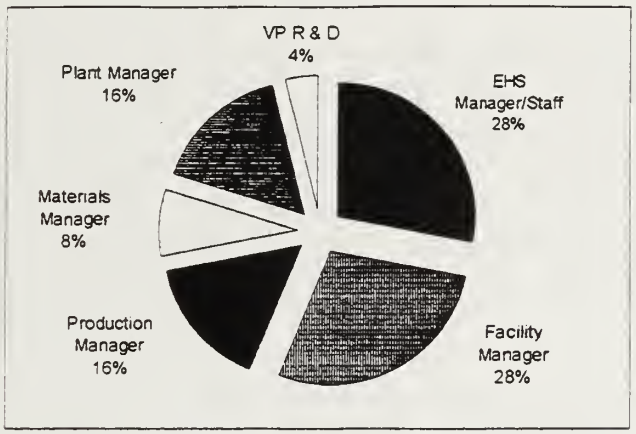
Category	No. of Firms
Firms Interviewed	25
TURA Filers at least once '90-'94	22
Prepared 1994 Plans	21
Prepared 1996 Plan Updates	19
DEP Multimedia Inspections	16
General Practice Planners	12
Limited Practice Planners	9
OTA LQTU site visits	8
OTA SQTU site visits	3

In-depth Investigation

In-person interviews ranged from forty-five minutes to four and one half hours, averaged two hours, and typically included a brief tour of the facility. In small firms, the person responsible for TURA often held several job titles. Greiner Environmental also interviewed other employees significantly involved in TUR activities. These other employees included managers, consultants, technical staff, and (in some cases) line workers. In total, 40 persons from the 25 firms were interviewed. Figure 2-1 details the positions of the persons with primary TUR responsibility. In addition, the facility's 1994 plan and 1996 plan update were reviewed during the interview as were written documents received as a result of a technical assistance site visit. Copies of the plan, the plan update, and the technical assistance letter were requested at the interview's close. Following each interview, a follow-up fax thanking the interviewee for participating was sent.

Figure 2-1 Position of Person With Primary TURA Responsibility

(n=25)



2.6. Data Analysis

Two types of data analysis were performed for this investigation, qualitative analysis of interview data and quantitative analysis of cost/benefit and toxics used reduction data. Qualitative data, such as responses on the quality of agency services and the efficacy of planning in the company's TUR efforts, were tabulated for each respondent. Greiner Environmental reviewed the tabulated data looking for themes, trends, and contradictions. Follow-up phone calls and faxes were used to clarify responses and fill in information gaps.

For the quantitative analysis, an Excel® spreadsheet was prepared for each firm containing all monetized cost/benefit data and quantified reductions in toxics use. Analyses were prepared to evaluate costs associated with Form S reporting, TUR plan preparation, and TUR plan update preparation. In addition, discounted cash flow analyses were used to determine the net present value (NPV) of 21 1994 TUR plans and 4 technical assistance site visits.

All financial analyses were adjusted to 1995 dollars. For the NPV analysis, an inflation rate of 5% , a discount rate of 12%, and 10 year straight-line depreciation were used. In-house labor rates for Form S, TUR plan and TUR plan update preparation were set at three rates:

managerial ($78.04/hr), technical ($58.67/hr), and clerical ($23.75/hr)[5]. In cases where production labor was effected by a TUR plan or technical assistance site-visit, company labor rates were used to quantify labor costs and benefits.

[5] Hourly wage rates for managerial, technical, and clerical staff are based upon a methodology used by Abt Associates Inc. in the *Benefit-Cost Analysis of the Massachusetts Toxics Use Reduction Act*. The methodology was developed for EPA's analysis of EPCRA Section 313 reporting (U.S. EPA, Office of Pollution Prevention and Toxics. *Economic Analysis of the Proposed Rule to Add Certain Industries to EPCRA Section 313*. June 1996.

3. Extent of Toxics Use Reduction Activity

Summary

Based on an analysis of the TURA data and augmented by qualitative interviews with each company, it appears that each of the 25 investigation firms has implemented one or more toxics use reduction changes between 1990 and 1996. Using TURA data from 1990 to 1994 reported by the 22 firms that file Form S reports during that time period, the average and median normalized byproduct reduction per year was 80,143 lb. and 3,848 lb. respectively The average and median normalized use reduction per year was 94,648 lb. and 2,350 lb. respectively. These reductions encompass a variety of chemicals including nitric acid, trichloroethylene, ammonia, and methanol. Firms in the investigation made these reductions by changing feed stock materials, redesigning products, modifying production processes, and recycling toxic materials.

Background

TURA's first policy goal, set forth in the preamble of the statute, establishes a statewide goal of reducing toxic waste 50% by the year 1997 using toxics use reduction as the means for meeting this goal. Section 2 of TURA defines toxics use reduction as in-plant changes in production processes of raw materials that reduce, avoid, or eliminate the use of toxic substances or generation of hazardous byproducts per unit of product produced. The Act defines six toxics use reduction techniques: input substitution, product reformulation, production unit redesign or modification, production unit modernization, improved operation and maintenance, and recycling, reuse, or extended use of toxics.

Examining whether investigation firms have implemented toxics use reduction techniques was one goal of the investigation. Two approaches were used to evaluate the TUR progress of the firms in the investigation: (1) an analysis of the 1990 to 1994 TURA data (the only TURA data available at the time of the investigation) and (2) questions regarding TUR projects during in-depth interviews with each firm.

Findings

The 1990 to 1994 TURA data was analyzed to determine TUR progress for the 22 firms that file TURA reports. The TURA data was analyzed by adjusting for changes in the level of production - known as "production adjusted measures" of TUR. To adjust for production, a weighted average production ratio methodology was used. The weighted average production ratio (PR_{WA}) is used to calculate projected chemical use and byproducts for each year. The projected quantities were then compared with actual quantities to determine the pounds of chemicals reduced (or increased) by TUR methods[6]. This methodology is somewhat limited in that it can only be applied to chemicals that are reported in two consecutive years. In addition, the method can only be applied to chemicals that were reportable in 1990. The Paradox™

[6]For a detailed explanation on the weighted average production ratios, see Toxics Use Reduction Institute, *Measuring Progress in Toxics Use Reduction and Pollution Prevention*, Technical Report No. 30, 1996, pages 7-4 through 7-9.

algorithms used to perform the analysis do not work for CERCLA chemicals added to the TURA list during 1991-1993.

The weighted average production ratio (PR_{WA}) is calculated using each TURA chemical's Form R production ratio and TURA Form S use data. The production ratios (for the 22 TURA filers) were combined by weighing the individual production ratios based on the total use reported for each production ratio. Mathematically:

$$(PR_{WA}) = \frac{\sum (PR_{2i})(TU_{1i})}{\sum TU_{1i}}$$

where:

i = all chemicals with non-zero use in year 1 and a PR>0 in year 2
PR_2 = production ratio for a chemical in year 2 (which is equal to production in year two divided by production in year one)
TU_1 = total use (manufactured + processed + otherwise used) for a chemical in year 1

Once the PR_{WA} has been calculated, it is used to calculate the projected quantities for the 22 TURA filers:

$$Q_P = Q_{T1} * PR_{WA}$$

and the normalized reduction or amount avoided is then:

$$Q_N = Q_P - Q_{T2}$$

where:

Q_N = total quantity avoided due to TUR (lb.)
Q_P = total quantity projected to be reported in the second year (lb.)
Q_{T1} = total quantity actually reported in year 1 (lb.)
Q_{T2} = total quantity actually reported in year 2 (lb.)
PR_{WA} = weighted average production ratio

To perform the analysis, the group of chemicals reported in two consecutive years were identified. Next the values of PR_{WA} , Q_P, and Q_N were calculated. Finally, the total quantity avoided due to TUR (Q_N) for 1990 to 1994 was computed by adding the quantity avoided for each two year period.

The 1990-94 TURA data, available for 22 firms, shows significant reductions in use and byproducts on a normalized basis. For the 22 firms required to file Form S reports, the total normalized use reduction equaled 2,082,261 lb. Normalized byproduct reductions for the 22 firms equaled 1,763,137 lb. On average, the 22 TURA filers reduced use and byproducts over a five year period by 94,648 lb. and 80,143 lb. respectively. Year-to-year use reductions ranged from 1% to 12% over the four year period. Byproduct reductions were greatest between 1990 and 1991 and declined as a percentage of total byproducts in each of the following years. Figures 3-1 and 3-2 and Table 3-1 and 3-2 present these results.

Figure 3-1 Projected vs. Actual Use

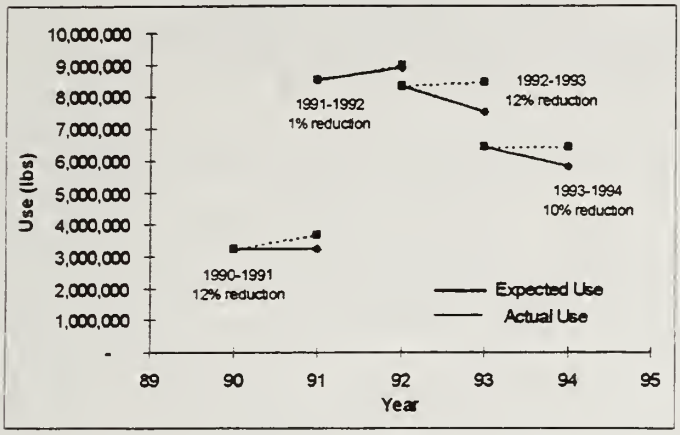


Figure 3-2 Projected vs. Actual Byproduct

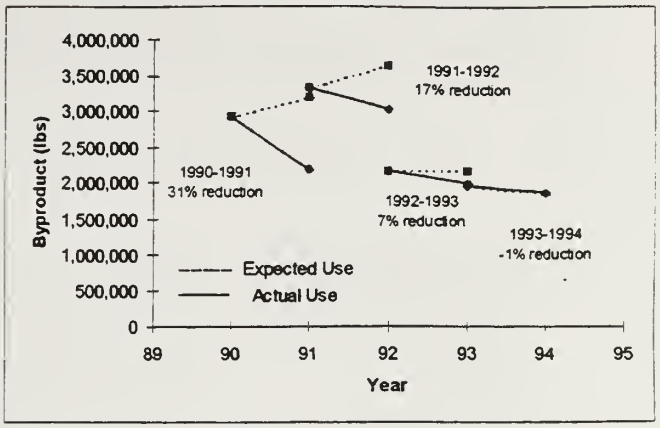


Table 3-1 1990-94 TURA Use Data

Year 1	Year 2	No. Facilities	No. Chemical Records	Year 1 Use (lb.)	Year 2 Use (lb.)	Weighted Ave Production Ratio	Projected Year 2 Use (lb.)	Avoided Use (lb.)	Percent Change
1990	1991	10	35	3,212,756	3,219,844	1.133	3,638,565	418,721	12%
1991	1992	15	26	8,505,472	8,892,984	1.058	8,994,620	101,636	1%
1992	1993	18	48	8,338,743	7,507,474	1.011	8,430,096	922,622	11%
1993	1994	17	42	6,416,074	5,785,773	1.001	6,425,055	639,282	10%
							TOTAL	2,082,261	

Table 3-2 1990-94 TURA Byproduct Data

Year 1	Year 2	No. Facilities	No. Chemical Records	Year 1 Byproduct (lb.)	Year 2 Byproduct (lb.)	Weighted Ave Production Ratio	Projected Yr. 2 Byproduct (lb.)	Avoided Byproduct (lb.)	Percent Change
1990	1991	10	35	2,915,554	2,189,352	1.133	3,189,826	1,000,474	31%
1991	1992	15	26	3,316,681	3,015,680	1.058	3,632,862	617,182	17%
1992	1993	18	48	2,160,118	1,989,900	1.011	2,144,951	155,051	7%
1993	1994	17	42	1,954,797	1,847,775	1.001	1,838,205	(9,570	-1%
							TOTAL	1,763,137	

TUR reductions varied greatly between firms. Normalized use changes varied greatly between firms - from 571,232 lb. reduced to 375,192 lb. increased over the five year period. The median normalized use reduction per year was calculated to be 2,350 lb. Normalized byproduct changes varied greatly between firms - from 692,648 lb. reduced to 356,004 lb. increased over the five year period. The median normalized byproduct reduction per year was calculated to be 3,848 lb.

The charts and tables above contain somewhat confusing discontinuities between each two-year measurement period. For example, in Table 3-1, the first row of Year 2 Use

(3,219,844 lb.) is not equal to the second row of Year 1 Use (8,505,472 lb.). This discontinuity is caused by the fact that the pounds of chemicals reported during *the two consecutive years* 1991-1992 were greater than during 1990-1991. Thus when the universe of reported chemicals changes from year to the next, so does the "baseline" used to project chemical use and byproducts. Despite the discontinuities, this method can be used to estimate a group of companies year to year change in chemical use efficiency.

Several other factors make precise TUR measurement for the study's 22 firms difficult:

- The weighted average production ratio assumes that changes in production result in directly proportional changes in chemical use and byproducts. This assumption is not always correct. A change in production may have a disproportionate effect on chemical use or byproduct generation.
- A firm may change its processes, products, and product mix in a manner not related to TUR. However the change may affect the chemical data reported in the company's Form S submission.
- Several firms filed their TUR data incorrectly. The problem was more acute in 1990 than in subsequent years.
- The weighted average production ratio method reflects only improvements in chemical use efficiency. It does not measure chemical substitution or reduction below the reportable threshold. This is because the method can be applied only in cases where a chemical is reported in two consecutive years.
- The methodology assumes that the production ratio is a reasonable reflection of how production changed from one year to the next. This assumption may not always be correct.
- Several data entry errors were made by the Department of Environmental Protection. This problem was acute in 1990 but non-existent in 1992, 1993, and 1994.
- The analysis does not examine changes in usage and byproducts in 1995 and 1996. This data was not available at the time this report was written. This factor is especially important since changes made as a result of the 1994 TUR plans were to be reflected in the 1995 and 1996 Form S reports.

The quantitative data analyzed above was supplemented with qualitative interviews with each company. The interviews confirmed the downward TUR use and byproduct trends. Each firm cited specific TUR projects carried out between 1990 and 1996 -- including the three small quantity toxics users (SQTUs) as well as the 22 large quantity toxics users (LQTUs). These TUR activities included redesigning products, modifying production methods, and improvements in operations and maintenance. The intensity of TUR efforts varied from firm to firm as well. Several firms had mounted aggressive TUR campaigns aimed at eliminating all TUR chemicals from their facilities. Other firms had set their sights on more limited goals, such as fine tuning a single production process or reducing a single chemical's byproduct generation.

4. Effect of TURA on Toxics Use Reduction Activities

An important goal of this study is to assess the impact of specific components of TURA on toxics use reduction and related business practices. Five major components of the TURA program were examined: reporting, planning, technical assistance, education and training, or regulatory outreach, compliance, and enforcement. This section examines to the extent to which the five components contributed to improvements in environmental management practices, environmental compliance performance, competitive position, materials accounting practices, and worker, health, and safety practices.

More than eighty percent of the firms in the investigation (21 of 25), cited TUR reporting, planning, technical assistance, education and training, or regulatory outreach, compliance, and enforcement as having prompted toxics use reduction changes at their facility. Respondents indicated that these changes were implemented over and above what otherwise would have been implemented at the site without the Act.

The investigation looked at each firm individually to assess what motivated the company to make toxics use reduction changes. While non-TURA factors were not the focus of the investigation, they were nevertheless reported to be important in motivating TUR changes. Non-TURA factors included the Clean Air Act Amendments of 1990, good business sense or saving money, improved plant safety, reduced compliance or regulatory relief, improvements in quality, and neighbor concerns. Eight other responses varied from the federal Toxics Release Inventory program to reduced equipment downtime. Table 4-1 presents TURA and Non-TURA factors that motivated firms to made toxics use reduction changes.

Table 4-1 Factors Motivating Toxics Use Reduction

Note: Firms had multiple responses

TURA FACTORS	No. of Possible Responses	No. of Responses
TUR Reporting	22	6
TUR Planning	22	15
Technical Assistance	11	10
Education and Training	11	10
Regulatory Outreach, Compliance, and Enforcement	25	4
NON-TURA FACTORS	**No. of Responses**	
1990 Clean Air Act Amendments	9	
Good Business Sense or Saving Money	9	
Improved Plant Safety	5	
Reduced Compliance or Regulatory Relief	4	
Improvements in Quality	2	
Neighbor Concerns	2	
Other Responses	8	

In-depth Investigation

The following sub-sections review the effect TURA has had on toxics use reduction activities at the companies in the study. Each sub-section begins with a summary of findings, is followed by background information, and ends with a discussion of the findings.

4.1. Form S Reporting

Summary

Thirteen respondents cited that Form S reporting provided little or no benefit to their operations. Benefits were cited in six cases and included better information on materials in product, process efficiency, and the nature and volume of waste streams. The average reporting costs per facility for first-time reporters, over and above Form R costs, averaged $1,813 per year. Second-time reporting costs per facility averaged $1,276 per year.

Background

Preparing and filing a Form S report is required under Section 10 of TURA. The Form S collects facility-wide and production-unit information on toxics use and byproduct. The Form S is designed to supplement the federal Form R reporting required under Section 313 of the Emergency Planning and Community Right to Know Act (EPCRA). DEP has responsibility for issuing the Form S reporting regulations and guidance and assuring compliance.

Form S reports are required of firms that have 10 or more full-time employees, conduct any business in Standard Industrial Classification (SIC) codes 10-14, 20-40, 44-51, 72-73, and 75-76, and qualify as a large quantity toxics users (LQTU). TURA defines an LQTU as any facility that manufactures or process 25,000 lb. or more or otherwise uses 10,000 lb. or more of a toxic substance. Firms that meet any of these threshold requirements must report on all listed chemicals used equal to or greater than 10,000 lb. The TURA toxic chemical list is comprised of those materials in the EPA Section 313 EPCRA list as well as materials on the EPA Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) reportable quantities list.

TUR reporting is viewed as serving a purpose for the public as well as individual facilities. The public uses TUR reporting data to evaluate TUR progress and target TUR resources (such as technical assistance services or TUR research). Facilities use TUR data as a basis for preparing TUR plans. Reporting data may help a facility learn more about the identity and quantity of chemicals it uses and wastes it generates. Such knowledge is an important step in making toxics use reduction changes to facility operations.

Respondents were asked questions regarding the costs and benefits of Form S reporting. Cost information included labor costs associated with preparing annual Form S reports. Benefit information included qualitative improvements in areas such as material handling, data tracking, and inventory control. Figure 4-1 on page 16 lists the questions used to collect this cost/benefit information for TURA reporting requirements for the years 1990 -1997. (Firms were asked to project their 1997 reporting costs.)

The estimated cost associated with preparing and filing From S reports is based upon three components: (1) the number of labor hours of each type of personnel required to complete the From S over and above that required to complete the federal Form R, (2) the hourly wage for each type of personnel, and (3) consulting fees. Respondents were asked to list the type of personnel preparing the reports and to estimate the number of hours for each year. Fully loaded

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1995 hourly wage rates based upon an EPA analysis of EPCRA Section 313 reporting (EPA, 1996) were applied to the estimated labor hours. The hourly loaded wage rates for each labor category were $78.04 for management personnel, $58.67 for technical personnel, and $23.75 for clerical personnel[7].

Figure 4-1 Investigation Questions Used to Estimate Form S Filing Costs

How many hours does it take to prepare the reports beyond that required to prepare EPA's Form R? Did filing in the first year require much more time than in subsequent years? Please quantify. *(indicate type of personnel as well as hours, If consultants were used, indicate fees charged(*

Year 1990 1991 1992 1993 1994 1995 1996 1997
Form S
(over and above the federal Form R requirements)

What benefits (if any) has your company received as a result of collecting data for the Form S? (data includes production unit and facility level materials accounting and unit-of-product data)

Findings

The average cost of Form S reporting per chemical ranged from $366 to $596. The average cost per facility ranged from $1,160 to $1,861. Form S reporting costs were expected to be greatest in the first year of reporting. Not all firms reported for the first time in 1990 -- three firms reported for the first time in 1991. First-time reporting costs per facility averaged $1,813. Second-time reporting costs per facility averaged $1,276. These costs are detailed in Table 4-2 below.

Table 4-2 Form S Reporting Costs

Reporting Year	1990	1991	1992	1993	1994	1995	1996
Facilities	16	18	21	20	19	17	17
Chemicals	50	59	76	75	61	53	52
Management Labor	$13,657	$8,194	$9,755	$8,194	$5,775	$5,229	$4,760
Technical Labor	$14,815	$12,078	$14,951	$29,032	24,338	$21,952	$21,952
Consulting Fees	$1,310	$1,310	$810	$810	$810	$1,100	$970
TOTAL	$29,782	$21,582	$25,516	$38,036	$30,923	$28,281	$27,683
Ave Cost/Chemical	$596	$366	$336	$507	$507	$534	$532
Ave Cost/Facility	$1,861	$1,199	$1,160	$1,811	$1,628	$1,664	$1,628

[7] Many of the underlying financial factors used here come from the *Benefit-Cost Analysis of the Massachusetts Toxics Use Reduction Act* prepared by Abt Associates. A common set of factors was used to make comparisons between the two studies possible.

The majority of firms in the investigation did not find the TURA Form S reporting significantly burdensome. Form S reporting for 11 of 21 Form S filers cost less than $500 per year. Three firms reported that the TURA filing was very burdensome. One of these firms manufactures extremely varied and complex products. The company invested significant resources in a computerized system to track the unit-of-product data needed for the Form S. The two other firms reported on numerous non-EPCRA chemicals. When a firm reports on a non-EPCRA chemical, the company must prepare not only the state Form S, but also a Form R. Preparing a Form R when it is not required by the EPA can dramatically increase a company's reporting costs.

Respondents were asked a question to assess the benefits of Form S reporting, "*What benefits (if any) has your company received as a result of collecting data for the Form S?*" Firms were specifically asked if other, non environmental personnel at the facility had or were using the Form S data. Six respondents cited that Form S reporting provided benefits to their operations. Twelve respondents cited that the Form S provided no benefits to their operations. Respondents at two facilities said they did not know or were unable to answer the question.

The benefits cited for Form S reporting include better information on materials in product, within the process, and in waste streams. Several firms stated that TURA reporting gave them a priority list of chemicals for their TUR efforts. Two firms cited TURA materials accounting requirements as having helped management understand more about the flow of materials through their production processes. One firm in the study used the byproduct reduction index (BRI) as a management tool for TUR planning (see Figure 4-2).

Figure 4-2 Using the Form S BRI as a Management Tool

Given the responsibility for TUR at a plant with over 4,000 employees, a large electronics manufacturer used the Form S byproduct reduction index to encourage toxics use reduction activities. The BRI, which is a measure of process efficiency, was especially useful in the firm's TUR planning efforts.

$$BRI = \frac{A - B}{A} \quad \text{where } A = \frac{byproduct(base \cdot year)}{production(base \cdot year)} \quad \text{and} \quad B = \frac{byproduct(current \cdot year)}{production(current \cdot year)}$$

To prepare the 1994 plan, the TUR planner taught the 14 member planning team basic materials accounting and TUR concepts. A sense of competition ensued among different departments as engineers took ownership for "their" BRI's. Plant engineers began examining their processes to find ways to reduce byproduct generation. By using the BRI to drive plan preparation, the primary planner transferred TUR responsibility to the persons responsible for running the production process. According to the lead planner, *"I got the idea for using the BRI this way from the TUR Planners course...(the course) had a big impact on how the plan was prepared.....The course taught me how to be an effective advocate (for TUR) at our facility"*

4.2. TUR Planning

Summary

TUR planning was one of the strongest forces motivating reductions in use and byproducts in the investigation. Of 21 firms that prepared plans, 11 firms stated that planning played a major role in prompting the company to not only consider but also implement TUR projects beyond that which would have occurred without the Act. Planning played a supporting role in the TUR efforts of four additional firms. The preparation of TUR plans played no role in TUR implementation at six firms in the investigation.

An accounting of the costs and benefits of the 1994 TUR plans showed that the plan benefits outweighed plan costs by $702,240. The formula outlined in Equation 4-1 was used to perform this analysis and calculate these results. Project savings included reductions in operation costs and overhead due to TUR implementation. Preparation costs included the labor and consultant costs to prepare the plan. Investment costs are comprised of capital expenditures for property, plant and equipment. Depreciation and tax effects included depreciation of investments and federal and state taxes on plan profits and losses.

Equation 4-1 Plan NPV Formula

Plan NPV = Project Savings - Preparation Costs
- Investment Costs - Depreciation and Tax Effects

Project savings for all 21 1994 plans totaled $1,513,420 and averaged $72,068. Only those projects implemented *as a result of preparing the TUR plan* were included in the analysis. If company included a project in a plan that they intended to implement anyway, benefits from that project were not included in the analysis. The average cost per 1994 TUR plan was calculated to be $16,248 and totaled $308,704. The median 1994 plan cost was $5,867. Capital investments totaled $208,206 and averaged $9,915 for 21 firms. Depreciation and tax effects totaled ($306,270) and averaged ($14,584). The plan net present value (NPV), equivalent to the savings from all plan projects minus plan preparation costs, project investment costs, and depreciation and tax effects, totaled $702,240 and averaged $33,440. These figures are summarized in Table 4-1.

Table 4-1 Total and Average Financial Results

	Plan NPV	Project Savings	Preparation Costs	Investment Costs	Depreciation and Tax Effects
TOTAL	$702,240	$1,513,420	($320,704)	($208,206)	($306,270)
Average	$33,440	$72,068	($16,248)	($9,915)	($14,584)

The pounds of toxic chemical use and byproducts avoided because of 1994 planning were quantified in cases were the data was available. The 21 planning firms cited use reductions totaling 342,680 lb. per year and byproduct reductions totaling 326,741 lb. per year. Firms in the investigation cited numerous benefits in addition to reducing toxic use and byproduct generation.

These benefits included improvements in product quality, improvements in worker health and safety, reduced environmental regulation, and increased knowledge of production processes and products.

The cost of preparing 1996 TUR plan updates was also calculated. The average cost per 1996 TUR plan update was calculated to be $10,414. The median plan update cost was $ 3,129. 1996 plan update costs averaged 50-65% of 1994 plan costs. Firms had just completed preparing their updates at the time of this study and had not yet implemented most projects. As a result, information on project savings, capital investment, and depreciation and tax effects were not collected for the 1996 plan update.

Background

Section 11 of TURA establishes the requirements for toxics use reduction plans. The planning process is designed to reveal to companies opportunities for toxics use reduction that make economic sense and that, in turn, companies will choose to implement. TURA does not require a firm to implement any TUR option. However, the state anticipates that when firms prepare TUR plans, "they often discover TUR techniques that they want to implement because doing so is in their best interest (DEP 1994 Planning Guidance p 2)."

Large quantity toxics users (LQTUs) were required to prepare plans by July 1, 1994, or by July 1 of the first subsequent year in which the firm was required to submit a Form S report. The guidelines for preparing TUR plans were designed to be flexible, thus permitting facilities to adopt the planning process to their particular site. However, all TUR plans must include the following:

1. a *facility-wide management policy* regarding toxics use reduction;
2. a *plan scope* that includes plan objectives and 2 and 5 year TUR goals;
3. *employee notification* of the planning process to solicit employee input;
4. a *process characterization* that includes materials accounting, process flow diagrams, the purpose of the chemical in the process, and a defined unit-of-product;
5. a *cost of toxics* analysis detailing the costs associated with using the toxic material;
6. a comprehensive *economic and technical evaluation* of TUR opportunities; accompanied by an implementation plan; and
7. a *plan summary* to be submitted to DEP.

Plans must be updated every two years and be certified by a licensed TUR Planner. Licensed TUR planners fall into two categories: limited practice and general practice. Limited practice planners must demonstrate seven years of experience in one or more DEP-qualified areas. Limited practice planners are licensed to certify their facility's plan only. General practice planners are required to take the TUR planners course (a 48 hour course) and pass an exam. General practice planners, who are often consultants, are licensed to certify any facility's plan.

Greiner Environmental examined how TUR plans were prepared, reviewed plans for content, and collected TUR-plan specific cost/benefit information. The Findings section presents the results of these analyses. Case studies detailing the planning efforts of two firms are located at the end of the Findings section.

In-depth Investigation

Findings

TUR planning was one of the stronger forces motivating reductions at investigation firms. Of 21 firms that prepared plans, 11 firms stated that planning played a major role in prompting the company to consider and then to implement TUR projects beyond that which would have occurred with out the Act. Planning played a supporting role in the TUR efforts of four additional firms. For these firms, planning aided in implementation by providing additional information to management, focusing TUR efforts, or improving projects the company planned to implement in the future.

While planning resulted in TUR implementation for the majority of firms in the investigation, six firms failed to implemented any TUR changes due to planning. Three of these firms believed *a priori* that they would not benefit from planning. Two firms already had pollution prevention programs in place and believed that planning was redundant. One firm had a single degreasing chemical and did not think planning was a useful way to change the process. These plans typically documented previous or planned toxics use reduction changes but did not include new TUR ideas.

There also appears to be a relationship between plan role in TUR implementation and the composition of the team that prepared the plan. The TUR Planner course places a heavy emphasis on the team-building process as do the TUR plan guidance documents and the plan preparation workshops sponsored by the TURA program. When prepared by teams comprised of employees, technical staff, and managers, a plan was more likely to play a major role or supporting role in TUR implementation than those plans prepared by an individual. Table 4-2 shows the relationship between plan role in TUR implementation and the composition of the TUR team that prepared the plan.

Table 4-2 Relationship Between Plan Role in TUR Implementation and Team Composition

	Human Resources Used to Prepare Plan			
Plan Role	Worker/ Technical/ Management Team	Technical/ Management Team	Individual Effort No Team	TOTAL
Major	5	6	0	11
Supporting	2	1	1	4
No	0	0	6	6
TOTAL	7	7	7	21

A Look at the Cost and Benefits of the 1994 and 1996 TUR Planning Process

To evaluate the cost and benefits of TUR planning, respondents were asked to provide cost and benefit data (where available) for their facility. The facility's 1994 plan and 1996 plan update were reviewed at the site. Qualitative costs and benefits were also assessed including changes in product quality, health and safety, and environmental performance. Firms were asked to identify those projects that were implemented as a result of the planning process. In cases were a firm included a project in their plan that the company intended to do anyway, the costs and benefits of that project were *excluded from the analysis*.

Cost/benefit data was collected from the 21 firms that prepared a 1994 TUR plan. Using this information, Greiner Environmental calculated each firm's project savings (in 1995 dollars),

plan preparation costs (in 1995 dollars), investment costs (in 1995 dollars), depreciation and tax effects (in 1995 dollars), and plan net present value (in 1995 dollars). The equation for a plan NPV is outlined in Equation 4-2[8]. An inflation rate of 5%, discount rate of 12%, 10-year project lifetime, 10-year straight line depreciation, and corporate tax rate of 40% was used to compute the value of each project[9].

Equation 4-2 Plan NPV Formula

Plan NPV = Project Savings - Preparation Costs
- Investment Costs - Depreciation and Tax Effects

Project Savings

Ten plans contained no financial information while eleven did contain financial data. For the most part, this financial data covered a narrow range of cost categories as opposed to a complete listing and quantification of all cost categories. For example, the financial data in most plans covered raw material costs and obvious treatment and disposal costs but not overhead or direct labor costs. Of the 11 firms that included financial analyses in their plans, one firm used net present value analysis -- however the analysis was performed incorrectly. The other 10 firms used payback analysis to evaluate their TUR projects. In many cases, the lack of project benefit data made it difficult to assess a TUR project's savings. As a result, project savings may have been underestimated in this study.

Complete or partial accounting of project savings were quantified for 12 companies by using information in the firm's TUR plan and by asking questions directed at quantifying the costs and savings of TUR projects. Project benefits for three firms were not quantifiable. Six firms stated that they had implemented no projects due to TUR planning. Two companies made investments in projects that resulted in a loss rather than a savings. These two firms implemented the projects because of their qualitative environmental, health, and safety improvements. Savings range from $776,965 to ($15,163). Project savings for all 21 1994 plans totaled $1,513,420 and averaged $72,068. For detailed project savings information, see Table 4-4 on page 24.

Preparation Costs

The cost of preparing plans and plan updates is based on three factors: (1) the number of labor hours required of each type of personnel involved in the planning process, (2) the hourly wage rates for each type of personnel, and (3) external consulting fees[10]. Labor hours required to prepare a plan and plan update were based upon in-depth interviews. Respondents were asked to detail their in-house labor costs and external consulting fees associated with preparation of their

[8] An investment is profitable if the NPV of the cash flow is greater than zero. For example, a project with a net present value of $1,000 is equivalent to having $1,000 cash in hand.

[9] The discount rate, tax rate, and escalation factor used in this analysis were adopted from rates and factors used in *Alternative Approaches to the Financial Evaluation of Industrial Pollution Prevention Investments*. Tellus Institute. 1991. The Tellus report uses a double-declining balance depreciation method. Greiner Environmental chose to use a straight-line depreciation method because it is simpler. It is also more conservative.

[10] This methodology for costing plan preparation was used to conform with methods used in the *Benefit-Cost Analysis of the Massachusetts Toxics Use Reduction Act (TURA)* by Abt Associates Inc.

1994 plan and 1996 plan update. Hourly wage rates for managerial, technical, and clerical staff are based upon a methodology used for EPA's analysis of EPCRA Section 313 reporting: $78.04 for managerial personnel, $58.67 for technical personnel, and $23.75 for clerical personnel.

The average cost per 1994 TUR plan was calculated to be $16,248 (based upon 19 of 21 firms -- consulting fees for two firms could not be determined). Plan costs ranged from as much as $150,000 to less than $1,000. The median 1994 plan preparation cost was $5,867. The average plan cost per chemical was calculated to be $4,758. The average cost per 1996 TUR plan update was calculated to be $10,414 (based upon 16 of 18 firms -- the consulting fees for two firms could not be determined). The median 1996 plan update preparation cost was $3,129. One company in the study had very high plan preparation costs. This outlier had a significant effect on the mean plan and plan update preparation cost. When this outliner is removed from the analysis, the average 1994 plan cost was $8,809 and the average 1996 plan update cost $4,502. 1996 Plan updates averaged roughly 50-65% of 1994 plan costs (see Table 4-3 for plan and plan update cost information).

Table 4-3 1994 Plan and 1996 Plan Update Costs ($1995)

Firm	1994 Plan Cost	1994 No. of Chemicals	1994 Cost/Chemical	1996 Plan Update Cost
Automotive Supplier	$150,138	4	$37,535	$90,083
Job Shop Metal Finisher I	$7,411	3	$2,470	na
Food Manufacturer I	$19,033	2	$9,517	$4,771
Food Manufacturer II	$2,408	2	$1,204	$1,908
Paper Converter I	$5,697	2	$2,849	$976
Paper Converter II	$4,635	7	$662	$1,173
Membrane Manufacturer	$5,867	2	$2,934	$2,934
Heat Treater	$6,995	1	$6,995	$5,330
Electrical Components	$26,167	10	$2,617	$17,445
Coating Supplier	$22,169	8	$2,771	na
Gear Manufacturer	$4,782	3	$1,594	$2,447
Container Cleaner	na	2	na	na
Job Shop Metal Finisher II	$6,839	5	$1,368	$3,772
Cable Manufacturer	$6,894	2	$3,447	$3,129
Leather Processing Firm	$5,582	2	$2,791	did not prepare update
Metal Processor I	$1,171	4	$293	$390
Job Shop Painter	$4,027	1	$4,027	$2,705
Military Parts Producer	$24,641	8	$3,080	$16,428
Plastic Extruder	na	1	na	$12,509
Job Shop Metal Finisher III	$936	1	$936	$624
Drum Reconditioner	$3,312	1	$3,312	did not prepare update
Average	$16,248	3.4	$4,758	$10,414
Average w/o Outlier	$8,809	3.4	$2,937	$4,502

In-depth Investigation

Investment Costs

TUR capital investment data was also compiled on the 1994 TUR plan. Three of 21 firms quantified capital investments made as a result of planning. These investments ranged from $8,960 to $173,690. Capital investments were made in valves, pressure regulators, piping, an aqueous degreaser, a reverse osmosis filtration system, and automated raw material handling equipment. One firm in the study was unable to provide information on capital expenditures. Seventeen firms reported no capital investments. TUR projects at these firms involved TUR changes that did not require an outlay for equipment -- i.e., raw material substitution for a less toxic input or modification of process parameters to improve chemical use efficiency. Capital investments totaled $208,206 and averaged $9,915 for 21 firms. For detailed investment cost information, see Table 4-4 on page 24.

Depreciation and Tax Effects

The depreciation effects of the three firms that reported capital investment were calculated using a ten-year straight-line depreciation method. These depreciation benefits were then adjusted to 1995 dollars using a discount rate of 12%. Tax effects for all 21 firms were calculated using a 40% tax rate. For firms whose planning benefits exceeded planning costs, the tax effects were negative. For firms whose planning costs exceed planning benefits, the tax effects were positive. Depreciation and tax effects ranged from $9,856 to ($93,853) and averaged ($13,359). For detailed depreciation and tax effects information, see Table 4-4 on page 24.

Plan Net Present Value

To examine the net financial impact of the 1994 TUR plans, Greiner Environmental calculated the plan net present value. The plan net present value (NPV) is equivalent to the savings from all plan projects minus plan preparation costs, project investment costs, and depreciation and tax effects. Plan net present values ranged from as high as $359,284 to as low as ($14,785). The average 1994 TUR plan update net present value was calculated to be $33,440. Plans with positive NPVs contained projects whose cash inflows exceeded the sum of investment and plan preparation costs. In most cases, negative plan NPVs were for those firms that had only preparation costs and no planning-related TUR savings (i.e., implemented no TUR projects).

Since all financial data was analyzed in 1995 dollars, each component of the financial analysis can be compiled according to the formula in Equation 4-3. The total NPV for all 21 firms was calculated to be $717,574. The plan NPV for all 21 firms is presented in Table 4-4.

Equation 4-3 Compiling Financial Data

$$\sum_{i=1}^{21} Plan\ NPV = \sum_{i=1}^{21} \text{Pr}oject\ Savings - \sum_{i=1}^{21} \text{Pr}eparation\ Costs - \sum_{i=1}^{21} Investment\ Costs - \sum_{i=1}^{21} Depreciation\ \&\ Tax\ Effects$$

Table 4-4 1994 Plan Financial Costs and Benefits ($1995)

Firm	Project Savings	Preparation Costs	Investment Costs	Depreciation & Tax Effects	Plan NPV	Comments
Automotive Supplier	$776,965	($150,138)	($173,690)	($93,853)	$359,284	
Metal Finisher I	$66,413	($7,411)	($8,960)	($15,292)	$34,750	
Food Manufacturer I	$176,718	($19,033)		($54,477)	$103,208	
Food Manufacturer II		($2,408)		$1,054	($1,354)	project benefits not quantifiable
Paper Converter I		($5,697)		$2,279	($3,418)	no plan projects
Paper Converter II	$5,992	($4,635)		($543)	$814	
Membrane Maker		($5,867)		$2,347	($3,520)	no plan projects
Heat Treater	$57,984	($6,995)	($25,556)	($4,785)	$35,982	
Electrical Components	$207,129	($26,167)		($57,472)	$123,490	
Coatings Supplier	$7,989	($22,169)		$5,312	($8,868)	
Gear Manufacturer		($4,782)		$1,913	($2,869)	no plan projects
Container Cleaner I (a)	$34,619	($9,516)		($12,043)	$13,419	
Metal Finisher II		($6,839)		$2,243	($4,596)	project benefits not quantifiable
Cable Manufacturer		($6,894)		$2,758	($4,136)	project benefits not quantifiable
Leather Tanner	($15,163)	($5,582)		$12,796	($7,949)	
Metal Producer		($1,171)		$469	($702)	no plan projects
Job Shop Painter	$8,369	($4,027)		($1,952)	$2,390	
Specialty Materials		($24,641)		$9,856	($14,785)	no plan projects
Plastic Extruder (b)	$189,740	($4,579)		($84,796)	$100,366	
Metal Finisher		($936)		$374	($562)	no plan projects
Container Cleaner II	($3,335)	($3,312)		$3,277	($3,370)	
TOTAL (c)	$1,513,420	($322,440)	($208,206)	($280,535)	$702,240	
Average	$72,068	($16,248)	($9,915)	($13,359)	$33,440	

(a) Firm's plan preparation cost for 1 chemical estimated to be $9,157 based on average plan cost for 2 chemicals from Table 4-3 (data not available from firm).

(b) Cost for general practice planner certification of plan with 1 chemical estimated to be $4,579 based on average plan cost for 2 chemicals from Table 4-3 (data not available from firm).

(c) Total Preparation Cost includes estimates for consulting fees for two plans -- see (a) and (b) above. These estimates were not used when calculating the average plan preparation cost.

Qualitative Benefits

The pounds of toxic chemical use and byproducts avoided because of planning were quantified in cases where the data was available. The 21 planning firms cited annual use reductions totaling 342,680 lb. and annual byproduct reductions totaling 326,741 lb. These reductions were for toxic chemicals such as nitric acid, chlorine, ammonia, methylene biphenyl isocyanate, and xylene. Qualitative benefits associated with planning and TUR implementation were also noted. These benefits included (1) improvements in business competitiveness (e.g., improved quality or reduced equipment downtime), (2) health and safety improvements; and (3) improvements in environmental performance. Table 4-5 lists the pounds of TURA chemicals reduced per year by each firm as a result of projected implemented due to planning as well other qualitative TUR benefits. Figure 4-3 presents these qualitative benefits in greater detail.

Table 4-5 1994 Plan Analysis - Qualitative Benefits

Firm	Use Reduction (lb./yr.)	Byproduct Reduction (lb./yr.)	Qualitative Benefits
Automotive Supplier	191,554	191,554	improved process knowledge, product quality, business decision making and decreased regulation
Metal Finisher I	3,255	3,255	improved workplace health and safety
Food Manufacturer I	55,000	55,000	a focus for environmental projects and improved health and safety
Food Manufacturer II	0	0	focus for environmental projects
Paper Converter I	0	0	
Paper Converter II	1,270	0	improved health and safety
Membrane Maker	0	0	
Heat Treater	8,219	0	improved process knowledge, product quality, and health and safety
Electrical Components	41,712	34,712	improved process knowledge and business decision making,
Coatings Supplier	3,000	0	improved compliance and business decision making and a focus for environmental projects
Gear Manufacturer	0	0	
Container Cleaner I	14,000	14,000	a focus for environmental projects, decreased regulation and improved health and safety
Metal Finisher II	NQ	NQ	improved process knowledge, compliance, business decision making, and focus for environmental projects
Cable Manufacturer	0	0	improved compliance and a focus for environmental projects
Leather Tanner	20,000	20,000	decreased regulation and improved health and safety
Metal Producer	0	0	
Job Shop Painter	495	495	decreased regulation and a focus for environmental projects
Specialty Materials	0	0	improved compliance
Plastic Extruder	NQ	NQ	improved health and safety
Metal Finisher	0	0	
Container Cleaner II	4,175	4,175	decreased regulation and improved health and safety
TOTAL	342,680	326,741	

NQ: reductions not quantified.

Figure 4-3 Qualitative Plan Benefits

Improved Product Quality

Projects implemented as a result of TUR planning led to improved product quality at two firms. For example, while preparing their TUR plan, a heat treater realized several furnaces controlled ammonia poorly. Ammonia is a process gas that controls furnace temperature and makes metallurgical changes to the product. The lack of control resulted in not only excessive ammonia use, but also large variations in product quality. According to the plant engineer, installing the flow control valves recommended in the plan, significantly lowered cost by reducing rework and scrap.

Improved Compliance

Two firms used the process characterization part of the plan to comply with EPA Clean Air Act risk management requirements and OSHA process safety requirements. Two other firms made significant improvements in materials tracking that translated into more accurate TURA and EPCRA reporting.

Process Knowledge

Planning gave firms increased knowledge of their operations. For example, one company began preparing to move to a new facility in 1995. The companies TUR plan, which contained detailed information on water and chemical use as well as product flow through the facility was used to design the new plant and purchase new process and treatment equipment.

Worker Health and Safety

Eight firms in the investigation used the planning process to make TUR changes that resulted in significant improvements in worker health and safety. At least two of these projects were negative NPV investments yet were implemented because they improved the work environment.

Reduced Regulation

Planning led to reduced regulation for five firms in the investigation. Three firms used the planning process to reduce volatile organic compound emissions. Two firm reduced their TURA chemicals sufficiently to drop below the TURA reporting threshold.

Focus for Environmental Projects

TURA planning helped to change the focus of environmental projects at several firms. These companies learned that the focus on prevention rather than end-of-the pipe was a better approach to solving environmental problems.

Better Decision Making

Forming cross-functional teams to prepare a TUR plan led to better decision-making processes at several firms. Specifically, the plan was the first time manufacturing and environmental personnel worked together to set priorities.

Figure 4-4 TUR Planning Case I

PLASTIC EXTRUDER, INC.

When faced with the task of preparing a TUR plan for zinc metal, Plastic Extruder's TUR planner formed a TUR team as a subcommittee of the company's safety committee. The TUR team was comprised of the company's production manager, engineers, purchasing staff, supervisors, and workers from the extrusion department. Team members met several times over three months to pinpoint TUR opportunities in the company's plastic extrusion process. The team developed three TUR options: (1) enclose the batching operation where zinc losses are greatest (zinc is mixed in powdered form with other raw materials in the batching operation), (2) improve zinc material handing and processing to reduce zinc byproduct, and (3) find a substitute for zinc where possible (zinc acts as an activator in the sheet extrusion process).

Plastic Extruder implemented each of the options. The first two changes did not have a significant overall impact on total zinc use at the facility (<5%) but did have a positive impact on worker health and safety. Zinc dust in the process is dispersed during handling and transfer processes. By improving materials handling and segregating the zinc transfer area from the rest of the production area, zinc dust in the plant was greatly reduced. Furthermore, the dust that was created could be more readily reused in the process. Quantitative cost/benefit data on these two projects was not available from the firm. The third option reduced zinc use by 20% per batch. The substitute raw material cost was less expensive reducing raw material costs approximately $25,000 per year (in 1995 dollars).

The 1994 plan cost the company $20,730 to prepare. Team members worked 220 management level hours on the plan at $78.04/hour and approximately 101 employee hours at $23/hour. The company hired a general practice planner to certify the plan for approximately $2,000. The net present value analysis of Plastic Extruder's planning efforts totaled $100,366 (using a 12% discount factor, a 5% inflation factor, 10-year project life-time, and a 40% corporate tax rate -- see profitability analysis in Appendix C).

TUR planning motivated Plastic Extruder to reorganize its environmental, health and safety (EHS) function. The EHS functions had been split between several persons. As a result of the plan, the company decided a full-time EHS coordinator would better serve the firm's EHS needs. Planning also lead to the institution of an informal chemical screening program. The company now screens chemicals it introduces on to the production floor in an effort to protect employees from harmful materials. According to the firm's production manager, these changes increased good will between the company and neighbors of the company's industrial park. Many of the workers on the TUR team and affected by the changes instituted at Plastic Extruder live in the community surrounding the plant.

While some firms find employees resistant to change work practices or formulations, Plastic Extruder, Inc. found the reverse. The company regularly involves workers in total quality management (TQM) efforts -- even inviting workers to give presentations on projects they have designed and implemented themselves. The firm's production manager noted the similarity between the TUR planning process the company's own TQM program. Both systems involve significant management commitment and employee involvement. As the production manager put it, "*preparing the TUR plan looked a whole lot like what we do all the time here at (Plastic Extruder).*"

Figure 4-5 TUR Planning Case II

AUTOMOTIVE SUPPLIER, INC.

Through TUR planning and work with the TURA Program, Automotive Supplier, Inc. has markedly improved its bottom line position and reduced the impact of its manufacturing activities and products on the environment. What synergy between the company and the TURA Program made this company achieve such notable results?

Automotive Supplier, Inc., a big three auto company supplier, faced severe financial crises in the early 1990's. The company was under pressure from its Detroit customers to simultaneously reduce product costs and improve product quality. To meet these demands, company managers sought gains in every department. However to the surprise of many, some of the company's biggest improvements came out of the firm's environmental improvement initiatives. Led by the Director of Environmental Affairs, Automotive Supplier initiated numerous projects to eliminate toxic-chemical cleaning steps, reduce equipment down time, and improve product yield. The Environmental Affairs Director (who is also the company's TUR planner) attributes his firm's TUR success to his work on TURA and the agencies that administer it.

A good example of the synergy between TURA and management objectives at Automotive Supplier is the preparation of the company's toxics use reduction plan. The Environmental Affairs Director saw that the team-based approach recommended in the TURI planner course fit perfectly with his company's team-based approach to safety and quality. The Director organized six TUR teams at the plant, one for each of the company's production units, and began a series of monthly worker/supervisor/management meetings. The teams set goals, evaluated their processes, brainstormed TUR techniques, and tested and implemented numerous TUR changes. The following is an excerpt from the company/s TUR Plan Mission Statement:

"....Our highest priority will be the proactive exploration of cost effective processes changes which will reduce or eliminate the use and/or generation of toxics at the point of production....We strongly support this concept and encourage all employees to forward their suggestions and recommendations for helping to reduce our reliance upon toxic substances. The safety and health of our employees is of major concern and can be enhanced by this program. Those that are toxic use reduction team members are empowered to make suggestions and to participate in the plan development. As part of the hiring and job promotion process, employees and candidates who are knowledgeable in plan work and are willing to participate will be given additional consideration. Because of the importance of this program, effective work in this areas will be recognized by executive management and additional incentives may be authorized as economic conditions permit."

Automotive Supplier's TUR team targeted all TURA materials in the facility, regardless of their level of use. The planning committee defined nine work centers and industrial processes for TUR analysis. These processes represented over 90% of the company's air emission and hazardous waste generation. The results from several of these analyses are presented below.

1. The *chlorination system* control circuits and piping as well as the cylinder control valves were upgraded primarily to benefit worker health and safety. The change reduced chlorine exposure and chlorine byproducts by roughly 100 lb. All though the net present

value of this investment was negative, the company decided that the investment's qualitative benefits outweighed its quantitative costs.

2. *Trichloroethane degreasing* was eliminated at Automotive Supplier in two ways. First, the company purchased an aqueous degreasing system. The aqueous system eliminated a large portion of the work cleaned in the company's solvent degreaser. Second, the company looked upstream to its suppliers and requested that they use vanishing oil in their operations. Vanishing oil does not need to be removed by a separate operation -- saving the company time and money.
3. *Acid and caustic* mold cleaning was eliminated. As a result of its TUR analysis, the company purchased a "dry ice" (CO_2) system to clean the molds. The dry ice cleaning process can be performed at the rubber press in minutes -- a significant time-improvement over the chemical-intensive process that required moving the molds off-line for cleaning. The TUR change also improved product quality. Since molds can be cleaned in minutes on-line (as opposed to taking hours offline), operators clean the molds more frequently. Cleaner molds has lead to a measurable reduction in rejects from the process.

Unlike some firms that passively approach planning, Automotive Supplier set aggressive TUR goals -- for example chemical elimination in several cases. The company held TUR team meetings for an entire year prior to when the 1994 TUR plans were due. Rather than pursue TUR opportunities for only those substances that require TURA reporting and planning, Automotive Supplier has focused its efforts on all TURA materials -- regardless of the quantities of use at the plant. TUR team meetings did not end with the completion of the firm's plan. The teams have met every month continuously since 1993.

The net present value of Automotive Supplier's 1994 TUR plan was calculated to be $359,284 (see NPV analysis in Appendix C). The company reduced its annual toxics use by more than 191,000 lb. per year. These benefits came because the company made significant capital and labor investments. Automotive Supplier, Inc., spent over $171,000 on capital equipment. The company purchased equipment to modify its chlorination process, zinc oxide and barium dispensing process, as well as its mold washing cleaning process. The company's TUR planning efforts cost the firm $150,138. These costs were comprised of management, technical, production, and clerical labor.

- $32,216 in management labor (400 hours at $ 78.04 per hour)
- $114,172 in technical labor and production worker labor (1,946 hours at $58.67 per hour)
- $4,750 in clerical labor (200 clerical hours at $23.75 per hour)

The company's TUR planner attributes his firm's TUR success to education, networking and technical assistance provided by the Toxics Use Reduction Institute and the Office of Technical Assistance. The planner has taken TURI sponsored courses, attended TURA program workshops, had numerous consultations with OTA and received two TUR ideas from a DEP multimedia inspection. According to the planner, TURA helped grow Automotive Supplier's business. TURA has helped to reduce manufacturing costs, redesign processes, and make the work environment safer for employees.

4.3. TUR Technical Assistance

Summary

Eleven investigation companies received technical assistance in the form of on-site reviews of their industrial operations. The technical assistance recommendations led to implementation of projects that reduced the use and waste generation of materials such as zinc, sulfuric acid, xylene, and water. Financial data was collected on technical assistance projects at three companies. As a result of the technical assistance recommendations, the three companies realized project savings of $1,106,851. These firms made capital investments of ($32,720). Depreciation and tax effects totaled ($117,652). The TUR projects implemented at these three companies as a result of technical assistance, resulted in a net present value $856,479. Compliance assistance was also provided during technical assistance on-site visits. Such assistance resulted in toxics use reduction projects at three firms. Technical assistance services were highly valued and viewed positively by all eleven firms. In all 11 cases, technical assistance services met or exceeded company expectations.

Background

Section 7 of TURA established the non-regulatory Office of Technical Assistance for Toxics Use Reduction (OTA). OTA was formed to assisted large and small quantity toxics users in TUR activities. The Office provides this free assistance through site visits, telephone assistance, and workshops or seminars. The identity of firms that receive technical assistance is kept confidential under Section 7 of TURA.

To examine how technical assistance fulfills its stated mission, respondents were asked a series of questions during the in-depth interview (see Figure 4-6 below). These questions examined the firm's experience with on-site technical assistance. Of the 25 investigation firms, 11 firms had received one or more site visits. Following each visit, the company typically receives a site visit report. Greiner Environmental reviewed these reports with facility personnel during the in-depth interviews. Report copies were requested following each interview. Copies were provided by eight firms.

Figure 4-6 Technical Assistance Site Visit Evaluation Questions

1. Can you recall OTA's TUR recommendations? If so, were OTA's recommendations researched further, tried, and/or implemented? Please explain and quantify where possible.
2. Was OTA's research and report completed in adequate depth and detail?
3. Was OTA's response to your request for assistance delivered in the time expected?
4. Were there any ancillary benefits other than those for which OTA was initially invited in to address?
5. If compliance assistance was given, was it adequate and effective?
6. If OTA services were not available, what would it cost you to get comparable services from a consultant?
7. What, in your opinion, could OTA have done to be more effective and meet your needs?

In addition to checking if technical assistance clients were satisfied with the site-visit service, cost/benefit data for each firm was collected. Financial data was used to compute a net

present value for all technical assistance-recommended projects. The Findings section presents the results of these analyses. Case studies detailing the technical assistance results at two firms are located at the end of the Findings section.

Findings

Of the 25 firms in the investigation, 11 received technical assistance. This assistance included methods to close-loop a pre-painting phosphating line, techniques to reduce the use and emission of zinc and glycol ethers, and technologies to reduce xylene use in a coating operation. Firms typically tested technical assistance recommendations and implemented them if the tests succeeded. In one case, a firm found technical assistance services to be of no value.

Compliance assistance was provided to seven of eleven site visit firms in areas such as the Clean Air Act operating permit program, wastewater permitting, and TUR plan preparation. In three cases, compliance assistance turned into an opportunity to implement TUR to achieve compliance. For example, OTA worked with a company out of compliance with the local sewer authority. The company, OTA, and the sewer authority developed a schedule to bring the company into compliance using TUR methods. The modified schedule permitted the firm to test and implement TUR changes rather than being forced to install end-of-the-pipe treatment technology. In another case, OTA responded to a firm's request to help with permitting a new piece of process equipment the firm planned to install. The Office reviewed the process and recommended TUR changes that eliminated the wastewater discharge for which the company was seeking a permit. Table 4-7 provides information on the implementation of technical assistance recommendations. Table 4-7 on page 32 lists all technical assistance recommendations and compliance assistance topics.

Table 4-6 Technical Assistance Implementation

Outcome	No. of Firms	Notes
Implemented some or all of the recommendations	4	Several recommendations resulted in significant environmental improvements.
In the process of testing the recommendation(s)	3	
Tested but did not implement the recommendations.	2	Both of these cases involved alternatives to solvents in printing clean-up operations.
Requested and received guidance on how to prepare a TUR plan	1	Several weeks before the plan were due the company realized it was required to prepare a plan.
Did not test nor implement OTA's recommendations	1	Firm is a fortune 500 business with significant technical resources. The planner stated that OTA did not offer ideas the firm had not already considered.

Table 4-7 Technical and Compliance Assistance

TUR Assistance
• replace toluene-based ink with less toxic ink
• replace aliphatic hydrocarbon cleaner with power washer and aqueous chemistry
• purchase HVLP spray guns
• substitute for TCE use in three processes
• substitute cadmium cyanide plating with zinc ammonia
• purchase in-tank filters for phosphate coating system
• improve inventory management to reduce waste generated by out-dated raw material
• develop a facility-wide environmental policy
• water conservation
• phosphoric acid recycling
• substitute ammonium zirconium carbonate for zinc ammonium carbonate to reduce zinc use and byproduct
• improved roll coating cleaning
• water conservation flow restrictors
• worker TUR training
• substitute non-toxic pigments for copper-based pigments
• substitute high-flash point cleaner for methylene chloride
• replace printing clean-up solvents with less toxic materials
• substitute high-VOC paint clean up chemicals with less toxic alternatives
• counter current rinsing in phosphating system
• in-tank filtration of phosphating system
• recirculated and reuse cooling water
• replace aliphatic hydrocarbon clean with aqueous cleaning system
• recycle and maintain metal working fluids
• improve painting transfer efficiency and clean up operations

Compliance Assistance Topic(s)
• TUR plan preparation (3)
• CAA VOC tracking requirements (2)
• CAA operating permit (2)
• Clean Air Act requirements
• waste water permit requirements
• RCRA waste storage
• Clean Air Act operating permit program
• permitting requirements to burn waste oil
• information on air emissions testing

Each of the eleven firms in the investigation stated that the technical assistance services they received met or exceeded their overall expectations. In each case, TUR research and site visit reports were completed in adequate depth and detail. In each case, a response to the company's request for assistance was delivered within the time expected by the company. Quotes from respondents, reproduced in Figure 4-7, reflect a generally positive view of the technical assistance they received.

Figure 4-7 Respondent Views of Technical Assistance

"I'm always happy with OTA"
-- Rubber Firm EHS Manager

"OTA can draw on lots of resources, education, and experience."
-- Paper Converter VP of R&D

"I found them to be very helpful ... they provide a good level of service... and a good referral service (to other networks or knowledgeable individuals)."
-- Consultant and Certified TUR Planner

"With OTA I had a good dialogue that opened up new ideas."
--Paper Mill Technical Manager

"The OTA visit gave me a heads-up on TURA planning."
-- Job Shop Purchasing Agent

"When in compliance problems with DEP... if you have OTA then it will buy you some time and good will from DEP (to work on coming into compliance)."
-- Wire Products Materials Manager

I use them all the time.... consultants do not know any more than (an OTA engineer)
-- Pump Manufacturer Facility Manager

"There is no intimidation... they are here to help you."
-- Tanning Company Plant Manager

Respondents had several suggestions to improve technical assistance services. These recommendations included a better review of recommendations (recommendations at two firms did not work when tested at the site) and bench-scale testing of TUR options (two firms specifically requested such a service). One firm (a job shop annodizer) felt that OTA did not know enough about their process. Another firm (a Fortune 500 defense contractor) commented that, "OTA came to the conclusion that they could not help us, (we) were already looking at their recommendations...although perhaps a good resource for small firms, OTA has not been able to help us."

A look at Costs and Benefits of Projects Implemented as a Result of Technical Assistance

To assess the costs and benefits of projects implemented as a result of technical assistance, Greiner Environmental collected qualitative and quantitative information during each in-depth interview. Costs attributable to projects implemented as a result of technical assistance include research and development costs, increases in operating costs, and capital expenditures on new equipment. Benefits attributable to these projects include reductions in operating costs, avoided permitting costs, avoided consultant costs, improvements in business competitiveness (e.g., improved quality or reduced equipment downtime), health and safety improvements; and improvements in environmental performance.

Of four firms that implemented TUR as a result of technical assistance, three firms were able to provide partial or complete financial data. Financial savings for projects at one plant could not be quantified. For the firms that could provide financial data, the data was analyzed to determine the project savings (in 1995 dollars), investment costs (in 1995 dollars), depreciation and tax effects (in 1995 dollars) and the net present value NPV of the projects (in 1995 dollars).

In-depth Investigation

An inflation rate of 5%, discount rate of 12%, 10-year straight line depreciation, and corporate tax rate of 40% was used for all projects[11].

Project Savings

Information on project implementation was available from three of four firms that had implemented TUR projects. This data was collected by working with the company to identify significant cost and savings categories and then quantifying these categories were the data was available. Since benefits at one firm could not be calculated, project savings may have been underestimated in this study. Savings range from $589,655 to $81,039. Project savings for all three firms totaled $1,106,851.

Investment Costs

Capital investment data was also compiled on investments made as a result of project implementation. Capital investments were made for valves, pressure regulators, nozzles, piping, an aqueous washer, filtration equipment, pumps, and tanks. These investments ranged from ($112,000) to ($5,600) and totaled ($132,720).

Depreciation and Tax Effects

The depreciation effects of the three firms that reported capital investment were calculated using a ten-year straight-line depreciation method. These depreciation benefits were then adjusted to 1995 dollars using a discount rate of 12%. Tax effects were calculated using a 40% tax rate. Depreciation and tax effects ranged from $107,211 to ($198,991).

Net Present Value of Technical Assistance Recommendations

The net present value NPV of projects implemented as a result of technical assistance (in 1995 dollars) ranged from $40,047 to $584,876. The NPV for each company can be added together to determine the net present value of projects implemented as a result of technical assistance at 3 companies. The net present value of all site visits was calculated to be $856,479.

Table 4-8 NPV of Projects Implemented As a Result of Technical Assistance

	Project Savings	Investment Costs	Depreciation and Tax Effects	Net Present Value
Paper Converter I	$589,665	$(112,000)	$107,211	$584,876
Metal Processor II	$81,039	$(15,120)	$(25,872)	$40,047
Pump Manufacturer	$436,147	$(5,600)	$(198,991)	$231,556
Total	$1,106,851	$(132,720)	$(117,652)	$856,479

[11] The analysis used in this section is similar to the analysis use to compare the costs and benefits of 1994 TUR plans outlined in section 4.2 on page 18.

In-depth Investigation

Technical assistance projects led to the use and byproduct reduction of 14,000 lb. of zinc per year, 19,708,00 gal of water per year and reductions (not quantifiable) in sulfuric acid, phosphates, copper, xylene, and 1,1,1 trichloroethane.

Figure 4-8 Technical Assistance Case Study No. 1

PAPER CONVERTER, INC.

In need of expertise to meet discharge limits set by the local waste water treatment authority, Paper Converter, Inc. turned to the Office of Technical Assistance. The company was faced with U.S. EPA enforcement action for exceeding its zinc and copper wastewater limits. If the firm could not find a solution to its violations, the sewer authority planned to require the installation of end-of-pipe treatment technology at a capital expense of $250,000 to $500,000.

Rather than require the company to install a treatment plan, the local sewer authority referred the company for technical assistance. Working together, Paper Converter, Inc., OTA, and the sewer authority began a systematic review of the company's operations. The review was conducted in stages. OTA and the company first concentrated on zinc discharges, then examined copper which exceeded discharge limits less frequently, and lastly worked to reduce water use.

OTA examined the main sources of zinc and copper in Paper Converter's waste water: printing operations, coating mixing, and kettle cleanup. OTA collected and analyzed over 200 water samples at locations throughout the plant. Working with the VP of Research and Development, OTA identified a means to reduce wash-up volumes and reuse copper containing ink as well as introduced a zinc-free chemical process. This zinc-free process, which involves replacing an acrylic aqueous system with one using sulfonated polyesters, increased raw material costs for the first three years the company used it. OTA also delivered in-plant water conservation and cleaning training to company workers.

The combined efforts of the sewer authority, the company, and OTA resulted in significant reductions in zinc and wastewater discharge. Process changes reduced zinc discharges by 60 % (12,000 lb. per year) and reduced wastewater discharge by 80% from 80,000 gallons per day to 12,000 gpd. These TUR changes brought the company into compliance. As a result, the firm was no longer required to build and operate a wastewater treatment plant.

Paper Converter invested $100,000 in water conservation improvements and implemented the more costly sulfonated polyester processes. The project's net present value was $584,876 in 1995 dollars (see analysis in Appendix C). The chief cost savings came from avoiding costs associated with building and operating a waste water treatment plant. Paper Converter's effort to reduce water use also generated significant positive cash flow for the company.

OTA played two important roles in its work with Paper Converter. OTA not only provided technical assistance, but also acted as a third party mediator between Paper Converter and the sewer authority. As a mediator, OTA developed a TUR evaluation and implementation time-line that was later reviewed and approved by Paper Converter and the sewer authority. The agreement outlined a schedule of pollution prevention milestones that guaranteed progress toward the goal of bringing the company into compliance. *The agreement was a notable departure from the traditional command and control approach used by regulatory agencies.*

Figure 4-9 Technical Assistance Case Study No. 2

METAL MANUFACTURER, INC.

Faced with the need to obtain a wastewater discharge permit, the facility manager at Metal Manufacturing called on OTA for assistance. He learned of OTA from a colleague at another firm and hoped the Office would help him go through the waste water permitting process for a newly installed phosphating system.

After a review of the phosphating system, OTA recommended eliminating the wastewater discharge all together by making the unit a closed-loop system. By installing a filtering system and counter-current rinsing, OTA believed that the company could operate the system without a wastewater discharge. Although this option was not part of the original equipment design, the facility manager decided to implement OTA's recommendations.

Since there was no guarantee that the closed-loop system would work, OTA suggested that the company file for a DEP industrial wastewater permit which does not require a professional engineer's stamp. Such a permit would give the company an option if the firm needed to discharge wastewater. This suggestion was far less expensive than those received by consultants who recommended a professional engineering stamped permit at an estimated cost of $9,000.

One year following OTA's site visit, the phosphating line has operated consistently without any wastewater discharge. The facility manager estimates that OTA's recommendations reduced water use several thousand gallons per year. Furthermore, the rinsing and filter system means water-polluting phosphates are not discharged to the local sewer authority.

A profitability analysis calculated that the project's net present value equaled $40,047 (see profitability analysis in Appendix C). Project costs included a $13,500 investment for a filter system and an annual filter replacement expense of roughly $1,500. Project benefits include avoided use of consultants and avoided treatment plant building, permitting, and operating costs.. The counter current rinsing and filtering system also reduced water use and phosphating chemical purchase costs.

The facility manager commented on his experience working with OTA:

"OTA was really helpful ... they would call the DEP and ask my questions... I think my involvement with (OTA) made my trip through the DEP much cleaner. I lacked (environmental management) knowledge and without OTA would have been more hesitant (to do the permitting myself) OTA greased the wheels for me by introducing me to process (of permitting). OTA is just as effective as a consultant ... a consultant would have cost $8-9K. OTA is very available and able to answer questions on the phone. They (OTA) do a lot to promote business in Massachusetts to help people to get up on (installing new process equipment that require permitting) and to decide not to get scared away by the rules and regulations."

4.4. TUR Education And Training Services

Summary

The Toxics Use Reduction Institute TUR planners course significantly affected how planners prepared their plans in ten of eleven cases. The course appears to balance the needs of more experienced planners without overwhelming less experienced planners. Firms whose planners took the course tended to prepare plans that resulted in TUR implementation. Several respondents suggested the course could be better organized. With respect to the planner's continuing education requirements, respondents were satisfied with continuing education requirements and offerings.

Background

Section 6 of the Toxics Use Reduction Act established the Toxics Use Reduction Institute (TURI) at the University of Lowell. TURI was established as a multi-disciplinary research and education center. The Institute's main activities include developing and administering a 48-hour course for toxics use reduction planners, sponsoring TUR education workshops and seminars, and conducting technology research on innovative technologies for toxics use reduction.

This investigation focused its evaluation on education and training programs. These programs include the 48-hour TUR planner certification course, continuing education workshops and seminars, and other TUR planning training courses. The Institute's educational programs are targeted primarily towards limited and general practice planners. Questions asked during the in-depth interviews to examine training and education services are listed in Figure 4-10 below.

Figure 4-10 Training and Education Evaluation Questions

1. Did you take the TURI Planner Course? If so, what skills did you learn via the course? How useful were these skills?
2. How did the TUR Planners Course affect the manner in which you prepared your firm's plan?
3. What is your impression of the TUR Planners Course offered by TURI?
4. What skills/information have you learned/gained through the continuing education requirements for TUR Planners?
5. What is your impression of the continuing education requirements for TUR Planners (prompt for positive and negative elements)?
6. What new and useful skills if any, did you learn via the course or continuing education workshops? How are they useful?
7. Have you established new (and useful) networks of information, professional colleagues, or resources through the course or continuing education workshops? Please describe the networks and how they are useful.

Findings

Eleven respondents (four general practice planners and seven limited practice planners) who had taken the planner's course were interviewed. In ten of eleven cases, respondents stated that the course had a significant effect on how they prepared their TUR plan(s). Ways the course aided planners included methods to characterize the production process, techniques for performing cost analysis, and tools for involving employees in the planning process. The chief

course benefits included a new network of TUR professionals, an introduction to new TUR technologies, and new skills to analyze production processes.

Persons with a wide range of education and experience take the TUR planners course -- from master-level chemical engineers to individuals with in-plant experience but no college-level education. A goal of course organizers is to offer a curriculum that challenges more experienced planners without overwhelming less experienced planners. The TUR planners course appears to meet this goal. Nine of the eleven respondents were generally pleased with the course's content. A tenth respondent, a masters-level chemical engineer, thought the course was too simplistic. The eleventh respondent, a nurse with no formal technical training, thought the course was too difficult. Respondent views of the planners course are located in Figure 4-11 below.

Figure 4-11 Respondent Views of Education and Training Services

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"The course affected how I prepared the plan -- specifically as far as getting others involved."
-- Paper Converter EHS Manager

"The course greatly affected how we prepared our plans. It was our 'guiding light'... for example on employee involvement, costing process, and the six ways to do toxics use reduction."
-- General Practice Planner (Consultant)

"TURI provided the guidance on how to prepare a plan.... all in all a fairly good program."
-- Specialty Materials EHS Manager

"The course had a big impact on how I prepared plans. Every plan I was involved with went very well."
-- General Practice Planner (Consultant)

"The course had a big impact on how the plan was prepared. Many TUR evangelists come out of TURI. Its library is the best source of TUR information. The Merrimak Business and Environment Network and other connections I got through the course have been very helpful."
-- Electronics Manufacturer TUR Planner

Of the 21 1994 TUR plans reviewed in the study, eleven were certified by general practice planners who had taken the course, six were certified by limited practice planners who had taken the course, and four were certified by limited practice planners who had not taken the course. As Table 4-9 indicates, the TUR Planners Certification course was associated with plans that played a major factor in TUR implementation.

Table 4-9 TUR Planner's Course vs. Plan-Related TUR Implementation

	Major	Supporting	None	TOTAL
Course	10	3	3	16
No Course	1	1	3	5
TOTAL	11	4	6	21

Major: TUR plan a major factor in TUR implementation.
Supporting: TUR plan a supporting factor in TUR implementation.
None: Plan had no effect on TUR implementation.

A few respondents felt the TUR planners course could be improved. Two respondents stated that the course was out-of-order. Two planners suggested that the course follow a flow

similar to the key steps one follows to prepare a TUR plan. One planner stated that the course should be condensed.

The investigation also examined the continuing education workshops and seminars organized by the Institute. On the whole, respondents were satisfied with the 30 hour planner continuing education requirement. A single respondent, a facility manager at a metal products company, suggested that the requirements were difficult to justify given that environmental management makes up a small fraction of his work responsibilities.

Respondents cited various workshops and seminars that they had attended and found worthwhile including the 1995 two-day planners conference, internet training, and surface cleaning workshops. The value of a professional TUR network was also emphasized by respondents. As one respondent said, "networking is very important -- you meet real business people that know real day-to-day aspects of the problems (you are working on)." Three respondents felt the continuing education offerings could be improved upon. Although short on specific suggestions, these respondents thought the offerings were "stale".

4.5. TUR Regulatory Services

Summary

On the whole, TUR regulatory services met the expectations of respondents. Guidance documents developed to assisted with Form S reports and TUR plans met or exceeded the information needs of nearly every firm in the investigation. TUR planners who telephoned the Boston DEP TURA office for help found the staff responsive and knowledgeable. However, respondent opinions on multimedia regulatory inspections were mixed. Half of the respondents approved of multimedia inspections -- primarily because the inspections conserved company resources by completing multiple inspections during a single visit. But nearly an equal number of respondents noted that multimedia inspectors were insufficiently trained and that such inspections were easier than their single media counterparts. Toxics use reduction strategies did not appear to be a prominent component of the multimedia inspections. Four of the 16 firms receiving multimedia inspections recalled regulatory inspectors recommending TUR.

Background

Section 3 of TURA established new duties for the Massachusetts Department of Environmental Protection (DEP). These activities include the development of regulations and guidance materials and the collection and management of TURA data. Furthermore, TURA requires the development and implementation of guidelines and regulations concerning multimedia inspections. The Act stipulates that to the extent practicable, any toxics user found to be violating any law or standard for which the department has enforcement jurisdiction, shall practice TUR in order to come into compliance.

The investigation reviewed a subset of these activities. First, comments were solicited on three TURA guidance documents prepared by the Department: (1) the Form S Reporting Guidance, (2) 1994 TUR Plan Guidance, and (3) 1996 TUR Plan Update Guidance. Second, the investigation examined the interaction between the Boston-based DEP TURA office and industry. Third, the investigation examined industry's view of multimedia inspections and whether such inspections promoted TUR.

Figure 4-12 Regulatory Outreach, Compliance, and Enforcement Evaluation Questions

1. Have you used the DEP planning and reporting guidance documents? If so, which ones and did they meet your information needs when preparing TUR reports and plans?
2. Have you called and asked the DEP TURA program staff a question? If so, what was the nature of the questions? Did the staff answer you questions in a timely manner? Do you find the DEP TURA staff knowledgeable about your issues of concern?
3. Has DEP asked for a data revision? Are you satisfied with DEP's request for corrections to your TURA data?
4. When were you last inspected by DEP? Was the inspection facility-wide? If so, was it different from previous single media inspections? How so? What are the +/- of single media vs. facility-wide inspections?
5. Was any enforcement action (e.g. notice of noncompliance) issued as a result of this inspection? Describe. Was TUR discussed in the inspection or notice of non-compliance?
6. Did the inspection and or enforcement action prompt you to:
   - undertake or investigate a TUR activity in any way? Describe.
   - contact OTA?
7. Did DEP review your TUR plan? Did the inspector comment on the plan? If so, please describe.

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Findings

With few exceptions, the 22 TURA firms in the study thought the TURA regulatory guidance documents met or exceeded their information needs when preparing their TUR Form S reports. While a few firms were initially confused by the definition of the term 'byproduct' and the byproduct reduction index, these issues have been ironed out with time. The planning guidance documents were also favorably viewed. Planners relied on these documents to guide them through plan development. However, several planners noted that the 1994 guidance was issued late and that the directions for filling out the 1994 plan summaries were confusing.

Nearly every firm that filed Form S documents or prepared a plan had called the DEP TURA Program Boston Office. Respondents found the Boston TURA regulatory staff "masterful", "tireless", "fine", "excellent", "good" and "very helpful". Three of eighteen respondents had negative comments but these were minor in nature (Two respondents pertained to regulatory staff being "confused" on their specific question. One respondent complained of a lack of communication between two regulatory assistance staff persons.) One problem that appeared during the first two years of TURA -- inaccurate Form S data entry -- appears to have been remedied. Greiner Environmental found that 1990 Form S data for four of 20 firms was not entered into the TURA database. In 1991, Form S data filed by one firm 1991 was not entered into the TURA database. No TURA database errors were found in 1992, 1993, or 1994 records.

TUR Compliance Inspections and Enforcement

Respondents held mixed opinions of multimedia inspections. Of the 25 firms in the investigation, 16 received multimedia inspections. Industry feedback on the multimedia inspections was mixed. Five respondents liked the inspections since they saved the company time and "got it all over with a single inspection". Two respondents noted that by having all media inspected, cross-media transfers are less likely. However other respondents felt certain multimedia inspectors were insufficiently trained in all media. Four respondents felt that the inspections were "easier to get through" and that multimedia inspections "were easier than single media inspections".

Toxics use reduction strategies were not a prominent component of the multimedia inspections. Only four respondents (of the 16 receiving multimedia inspections) recalled compliance inspectors recommending TUR -- one in a notice of noncompliance (NON) and three during the inspection itself. In the case of the NON, the company was required to improve VOC control by placing covers on solvents while not in use. Two of the three inspection recommendations were implemented. In the first case a firm eliminated mineral spirits and methylene chloride parts washers as a result of the inspector's comments. In this case, the inspector knew the firms EHS manager having taken the TUR Planner course together. In the second case, the inspector recommended housekeeping improvements and TUR options in the firm's painting operation.

TUR plans received infrequent review during the 16 multimedia inspections examined in the investigation. Only five of 16 respondents recalled inspectors reviewing their plan. In one case, the inspector was dissatisfied with some sections of the plan and suggested areas needing improvement. In four cases, the inspector offered no comments on plan completeness. Greiner

In-depth Investigation

Environmental found one of these TUR plans to be inadequate. The plan lacked several sections including the process characterization, financial analysis, and cost of toxics. According to firm's environmental manager the inspector did not comment that the plan was incomplete, nor did the Department undertake enforcement action as a result of the plan inspection. This particular plan was certified by a general practice planner employed by one of the company's suppliers. This general practice planner did not visit the site before certifying the plan. While this information on plan inspections is anecdotal, it points to a need to train inspectors on TUR plan inspection procedures.

5. Conclusions

Based on the results of this investigation, the Act appears to be fulfilling its intended purpose of reducing toxic chemical use and byproduct generation. In a significant number of cases (21 of 25 firms), reporting, planning, technical assistance, education and training, or regulatory services have been used to implement toxics use reduction.

For firms in the study, the Act appears to be have increased business' knowledge of toxics use reduction -- including cleaner technologies, new process analysis methods, and better integration of environmental concerns into business decision making. The Act has also led to the formation of a network of TUR professionals noted by respondents as important to their work.. These TUR professionals include in-plant environmental staff, consultants, and company managers that with environmental responsibilities. TURA provides this network with access to technical assistance, education and training, cleaner production technology information, grant programs and opportunities to network with other toxics use reduction professionals.

Form S Reporting

A minority of firms (~32%) that prepared annual Form S reports found the reports useful for environmental and/or business decision making. That so few firms found Form S data beneficial is surprising for several reasons. First, Form S data is the basis upon which firms prepare their 1994 TUR plans. Respondents noted that TUR plans played a major or supporting role in TUR implementation in 15 of 21 firms. Second, TURA chemicals have become an important focus of industry source reduction efforts. Without the Form S reports, many firms would lack a chemical list and metric to track their reduction efforts. The value of Form S reporting may have been under-reported because firms do not recognize the linkages between the Form S and their TUR plans and TUR corporate programs.

While the annual Form S reports were helpful in determining the types of chemicals used at a facility as well as the firm's main processes and products, it was difficult to use this data to pinpoint the TUR progress of individual facilities. Many factors contribute to the problem of TUR measurement, including reporting errors, data entry errors, and difficulties adjusting the data for changes in production. Furthermore, the byproduct reduction index (BRI) cannot be used to measure a facility's progress since the individual BRI's cannot be added together. Modifications to the Form S, such as those outlined in *Measuring Progress in Toxics Use Reduction and Pollution Prevention*, would make measuring TUR progress for a facility or group of facilities simpler[12].

It appears that for most firms, Form S reporting costs were not a significant financial concern nor were Form S reports a significant confidential business concern. Form S reporting costs averaged $1,813 per year for first-time reporters and $1,276 for second-time reporters. While three facilities did have substantially higher reporting costs, these firms appear to be an exception to the rule.

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[12] Harriman E and Hart M. Measuring Progress in Toxics Use Reduction. Toxics Use Reduction Institute. University of Massachusetts Lowell. Technical Report No. 30. 1996. Pages 9-8 and 9-9.

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TUR Planning

The investigation found that TUR planning caused firms to make toxics use reduction changes over and above what would have been implemented at the site. TUR planning led to approximately 340,000 lb. of use and ~320,000 lb. of byproduct reduction and to improvements in product quality, improved workplace health and safety, reduced regulation, and more accurate materials accounting. An analysis of financial data provided by firms in the investigation, calculated that the net present value of 21 1994 TUR plans totaled over $720,000.

The investigation found that planning efforts varied from firm to firm but that more than 70% of the firms in the study said planning played a major role or a supporting role in TUR implementation. Firms that prepared plans using management, technical, and workers had greater TUR success than firms whose plans were prepared by a single individual. More successful planning (as measured by toxics use reduction implementation) was associated with those prepared by or certified by individuals who had taken the TUR planners course. The course helped TUR planners with strategies to increase management, technical, and worker involvement in the planning process. The course also gave planners tools to characterize their processes and develop TUR options.

One component of the planning process that firms consistently omitted or prepared poorly was the financial analysis section. Slightly less than half of the 21 plans reviewed did not contain any section on financial analysis. Of those firms that did perform a financial analysis, the analysis typically examined only obvious cost categories, such as waste disposal, raw material, and waste treatment. Only one firm used net present value analysis (and this analysis was performed incorrectly). The other firms that performed a financial analysis used simple payback calculations to determine the profitability of their proposed TUR projects. While complex financial analysis of TUR projects is not necessary in every case, capturing all of the costs in an analysis and using tools that include the time-value of money may increase the likelihood that project will be implemented.

TURA Agency Services

The TURA technical assistance, education and training, and regulatory outreach, compliance, and enforcement services met or exceeded the needs of a majority of firms in the investigations. Technical assistance services, in the form of TUR recommendations and compliance assistance, were widely praised. For example, all investigation firms that received technical assistance stated that it was provided in adequate depth and detail and within the time expected by the firm. Technical assistance was also helpful in resolving compliance problems. Three of 11 investigations firms that receive technical assistance, used the service to resolve resolving regulatory compliance problems via toxics use reduction.

Toxics use reduction training and education services were cited for their helpfulness in preparing TUR plans and for establishing a network and forum for TUR planners to interact with one another. Planners learned TUR tools such as process characterization, options identification, and materials accounting and applied these tools in their efforts to prepare TUR plans.

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Respondents did recommend changes to improve TURA's technical assistance and education and training services. For technical assistance, two (of 11) respondents felt that recommendations should have been more carefully screened or perhaps even pre-tested before being suggested to the company. In the area of training and education, two respondents suggested ordering the TUR planners course similar to the key steps one follows when preparing a TUR plan. Three respondents suggested that continuing education offerings were stale and in need of new content. These responses suggest the need for continuous improvement of technical assistance and education and training services. Feedback and corrective action mechanisms such as industry advisory committees, currently in place at both OTA and TURI, should be used to keep the services current.

As with technical assistance and education and training, respondents held generally positive views of regulatory outreach services (provided by the DEP TURA Boston Office). Greiner Environmental found that the guidance documents, workshops and training available to firms for preparing Form S documents, TUR plans, and TUR plan updates met or exceeded planner needs. And although there were problems with entering the 1990 TURA data and to a lesser extent the 1991 TURA data correctly into the TURA database, there were no data entry errors in subsequent years.

The TUR services in greatest need of improvement are in the area of TUR compliance and enforcement performed by inspectors located in regional offices. Although based on a limited sample, Greiner Environmental found that toxics use reduction strategies were not well integrated in regional compliance and enforcement activities. Few firms (four of 16) could recall toxics use reduction being mentioned during their inspections. Only five of 16 firms could recall inspectors reviewing their TUR plans. Generally speaking, inspectors seemed not to see TUR as an integral part of their compliance and inspection duties.

Appendix A: In-Depth Survey Instrument

PART 1: FIRM and TUR HISTORY

1. Can you give me a little history lesson on the company? When was the business started?

2. Tell me about your company's business. What products do you manufacture? What processes do you use? What markets do you compete in?

3. Would you tell me about the most significant changes in the past 5-10 years with regard to changes in
   - management of the company
   - products
   - production processes
   - competition
   - environmental management
   - management focus (e.g. quality, cycle time, cost reduction, or new product introduction)

4. Does your firm have a quality program? ISO program?

5. Firm Demographics
   - union _____ # employees _____
   - sales (div/corp) _____ how firm competes (price, quality, niche) _____

6. How is environmental management set up in this company? What is the history, how did it get the way it is today?

7. When were you hired by this company? Would you tell me a little about your career path?

8. Tell me about your job as environmental manager. What do you do? Who do interact with? Could you draw an organization chart showing the env. department's location?

9. Would you give me another little history lesson, this time on toxics use reduction? For example, when did you first learn about toxics use reduction (as a concept)? What were the early TUR things you remember working on? What have you worked on more recently?

1. _____

2. _____

3. _____
   a) _____
   b) _____
   c) _____
   d) _____
   e) _____
   f) _____

4. _____

6. _____

7. _____

8. _____

9. _____

PART 2: TUR REPORTING & PLANNING

1. Do you prepare your company's Form S reports? (If YES) In your opinion, what is the purpose for requiring businesses to complete Form S reports? Is that purpose being met?
2. How many hours does it take you to prepare the reports beyond that required to prepare EPA's Form R? Did filing in the first year require much more time than in subsequent years? If so, please quantify.
3. What benefits (if any) has your company received as a result of collecting data for the Form S? (data includes production unit and facility level materials accounting and UOP data)
4. Are you a certified TUR planner? GP or grandfathered?
5. Who is your firm's primary planner? Who else was significantly involved (prepared >10% of the plan)?
6. How was your TUR Plan prepared? Was it distributed among several people, centrally coordinated, or managed in some other way. If consultants were used, what portion of the plan did they prepare? What did they charge? If GP planner was used, please describe their role along with +/- of using a GP.
7. What were the main activities involved in preparing the plan? How much time did it take you to prepare the plan?

   _____ attending workshops
   _____ attending the TUR Planner course
   _____ attending meetings

8. What, in your opinion, is the purpose for requiring businesses to complete a TUR plan? Is this purpose being met?
9. How many times since '94 have you referred to your TURA plan. Describe.
10. What percent of your plan update have you completed? What resources (time/$) have you/will you devote to the update?

1. _____

2.

	1991	1992	1993	1994	1995	1996	1997	1998
Form R								
Form S								

3. _____

4. _____

5. _____

6. _____

_____ goal setting
_____ management policy
_____ employee input
_____ cost of toxics
_____ MA (plan year)
_____ MA (other years)

_____ PF diagrams
_____ cost of toxics
_____ identifying options
_____ evaluating options
_____ implementation

8. _____

9. _____

10. Primary Planner: _____ Significant Others: _____
    Consulting Fees: _____

11. Please list the main TUR projects your company has planned for and/or completed over the past SIX years

A. _____

In plan? _____ Implemented _____

B. _____

In plan? _____ Implemented _____

C. _____

In plan? _____ Implemented _____

D. _____

In plan? _____ Implemented _____

E. _____

In plan? _____ Implemented _____

F. _____

In plan? _____ Implemented _____

G. _____

In plan? _____ Implemented _____

A. _____

B. _____

C. _____

D. _____

E. _____

F. _____

G. _____

(GO TO PART 3: PROJECT DATA COLLECTION SHEET. ONCE COMPLETE, RETURN TO QUESTION 12 BELOW)

12. Qualitative Benefits: Would you describe any firm-level qualitative benefits due to TURA? e.g.

- improvements in staff morale/ firm performance
- reduced worker exposure/risks
- improved corporate goodwill

12. _____

13. We have discussed projects you have implemented but have not discussed barriers to further TUR. What do you believe are the main barriers to further TUR? (prompt for: capital availability, human resources, competing priorities, tech feasibility, customer acceptance, management support, resistance to change, other)

13. _____

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14. In your opinion, has TUR planning and/or reporting changed the focus of env management practice at your company? (Ask about systematic planning, materials accounting, and general TUR orientation if not mentioned.)

14. _____

15. Did TUR planning motivate the implementation of TUR options that had been considered prior to planning? Describe. If there was no planning requirement, which TUR activities that you implemented would you have implemented anyway?

15. _____

16. If the planning requirements were removed, would you continue to plan?

16. _____

PART 3: PROJECT DATA COLLECTION

Project Name: _____

1. Brief Description of Project
   e.g. process, chemical(s), description of change

   1. _____
   _____

2. When was this project initiated? completed?

   2. _____

3. Who worked on this project?

   3. _____
   _____

4. What were the main drivers for making the TUR change?
   (prompt for $ savings, WHS, environmental, compliance, quality, throughput, meet TUR goals, other)

   4. _____
   _____
   _____

5. What were your main resources for making the change come from? (prompt workers, consultants, Eng., trade literature, other)

   5. _____
   _____

6. Would you please quantify the reductions from your TUR project?
   material 1 _____
   material 2 _____
   material 3 _____
   material 4 _____

7. Would you please identify the following cost/revenue categories that changed due to the project? Please indicate the direction of the change.

Materials
- __ raw materials in product
- __ wasted raw materials
- __ transport
- __ storage

Waste Mgt (Mat's & Labor)
- __ pre-treatment
- __ on-site handling
- __ storage
- __ hauling
- __ insurance
- __ disposal

Utilities
- __ electricity
- __ refrigeration
- __ steam,cooling & process water
- __ fuel (gas and oil)
- __ plant air & inert gas
- __ sewerage

Direct Labor
- __ operation labor & supv
- __ manufacturing clerical labor
- __ inspection (QA/QC)
- __ worker productivity changes

Indirect Labor
- __ maint (materials & labor)
- __ misc. (eg. housekeeping)
- __ medical surveillance

Regulatory Compliance
- __ monitoring
- __ manifesting
- __ reporting
- __ notification
- __ record keeping
- __ training (RTK, safety, etc)
- __ training materials
- __ protective equipment
- __ labeling
- __ lab fees
- __ penalties, fines
- __ insurance
- __ handling (RM & waste)
- __ R&D to comply with regs

Revenues
- __ sales of product
- __ marketable by-product
- __ throughput increase
- __ increased market share
- __ improved corporate image
- __ improved O & M
- __ more accurate product pricing

Future Liability
- __ fines and penalties
- __ personal injury

Qualitative Effects
- __ employee health and safety
- __ empl morale/job satisfaction
- __ relations with reg agencies
- __ relations between workers & management
- __ better knowledge of the process

8. Quantification of Relevant Costs/Revenues

$_____Capital Equipment Costs

$_____Raw Material Savings (e.g. acid or caustic savings, plating bath savings due to extended bath life)

$_____Waste Mgt. savings (e.g. pre-treatment, disposal, on-site handling, etc.)

$_____Utilities (e.g. electricity or steam, cooling & process water)

$_____Direct Labor Costs (e.g. operation labor, inspection (QA/QC) or worker productivity changes

$_____Regulatory Compliance Costs (e.g. monitoring, manifesting, record keeping, etc.)

$_____Other significant costs or savings from the project (please describe:_____

_____

* Has the project had any of the following qualitative effects? Please check if significant:

_____employee health and safety

_____employee morale/job satisfaction

_____relations with reg agencies

_____improved O & M

_____Other (Describe: _____)

_____throughput increase

_____better knowledge of the process

_____improved corporate image

_____relations between workers & manag

* What is your firm's cost of capital? _____

* What is the expected lifetime of the equipment you purchased for the project? _____

PART 4: AGENCY INTERACTION

1. What type of interaction (e.g. workshop, site-visit, inspection, or TUR Planners course) have you had with:
   - The Office of Technical Assistance
   - The Toxics Use Reduction Institute
   - The Department of Environmental Protection

1. _____

----------OTA Association----------

2. Can you recall OTA's TUR recommendations? If so, were OTA's recommendations researched further, tried, and/or implemented? Please explain and quantify where possible.

2. _____

3. Was OTA's research and report completed in adequate depth and detail?

3. _____

4. Was OTA's response to your request for assistance delivered in the time expected?

4. _____

5. Were there any ancillary benefits other than those for which OTA was initially invited in to address?

5. _____

6. If compliance assistance was given, was it adequate and effective?

6. _____

7. If OTA services were not available, what would it cost you to get comparable services from a consultant?

7. _____

In-depth Investigation

8. What in your opinion could OTA have done to be more effective and meet your needs?

8. _____

----------TURI Association -- TUR Planners----------

9. Did you take the TURI Planner Course? If so, what skills did you learn via the course? (prompt for env mgt, team building, planning, general TUR skills, skills for job functions other than env. mgt) How useful were these skills?

9. _____

10. How did the TUR Planners Course affect the manner in which you prepared your firm's plan?

10. _____

11. What is your impression of the TUR Planners Course offered by TURI? (Prompt for + elements and - elements)

11. _____

12. What skills/info have you learned gained through the continuing education requirements for TUR Planners? (Prompt for positive elements and negative elements)

12. _____

13. What is your impression of the continuing education requirements for TUR Planners (prompt for positive and negative elements)?

13. _____

14. What new and useful skills if any, did you learn via the course or continuing education workshops? How are they useful? (prompt for env. mgt, skills for TUR planning, and)

14. _____

15. Have you established new (and useful) networks of information, professional colleagues, or resources through the course or continuing education workshops? Please describe the networks and how they are useful.

15. _____

16. What other services have you received from TURI? (prompt for matching grants, Surface Cleaning Lab, other)

16. _____

----------DEP Association----------

17. Have you used the DEP planning and reporting guidance documents? If so, which ones and did they met your information needs when preparing TUR reports and plans?

19. Have you called and asked the DEP TURA program staff a question? If so, w hat was the nature of the questions. Did the staff answer you questions in a timely manner? Do you find the DEP TURA staff knowledgeable about your issues of concern?

19. Has DEP asked for a data revision? Are you satisfied with DEP's request for corrections to your TURA data?

20. When were you last inspected by DEP? Was the inspection facility-wide? If so, was it different than previous single media inspections? how so? What are the +/- of single media vs. facility-wide inspections?

21. Was any enforcement action (e.g. notice of noncompliance) issued as a result of this inspection? Describe. Was TUR discussed in the inspection or NON?

22. Did the inspection and or enforcement action prompt you to:
    - undertake or investigate a TUR activity in any way? Describe.
    - contact OTA?

----------Program-Wide Question----------

23. If we were to define the 'TURA Program" as TUR planning, Form S reporting, OTA technical assistance, TURI planner education and research, and DEP regs, compliance, and enforcement, what aspects of TURA would you deem (if any)
    (a) 'result in the greatest benefit to the facility" and 'most strongly motivated reductions in toxics use reduction'?
    (b) 'result in the least benefit to the facility" and 'motivated reductions in toxics use reduction least'?

17.

18.

19.

20.

21.

22.

23(a)

23(b)

Appendix B: Sample Pre-Interview and Post Interview Fax Letters

GREINER ENVIRONMENTAL

2 Emily Lane
Gloucester, MA 01930

March 5, 1997

Name
Frm
Adress
Town, MA zipcode

Dear Tom:

I am writing you regarding the research Greiner Environmental is conducting as part of an independent evaluation of the Massachusetts Toxics Use Reduction Program. The purpose of this evaluation is threefold:

1. to understand whether and how firms in Massachusetts have implemented TUR;
2. to assess the impact of specific components of the TURA Program on a firm's environmental and business performance; and
3. to contribute to an assessment of the costs and benefits of the TURA program.

As part of this evaluation, Greiner Environmental was awarded a contract to randomly select and interview 25 firms. Typical study interviews last two hours. The identity of all study participants and all information collected during the interview will be kept confidential. At the completion of the project, Greiner Environmental will issue a report summarizing the study's findings.

This is a very important project to evaluate the impact TURA has had on the Commonwealth's environment and economy. Your participation gives you an opportunity to comment on the effectiveness of the state's Toxics Use Reduction Program.

I will call you shortly to discuss the project further and see if we can schedule an interview.

Sincerely,

Timothy J. Greiner, Principal
MBA, MCP, Certified Toxics Use Reduction Planner

GREINER ENVIRONMENTAL

2 Emily Lane
Gloucester, MA 01930

Date

Name
Firm
Street
Town, MA zipcode

Dear Name:

I am faxing you the data collection sheets that we discussed on the phone. I have put together a sheet for two of the projects in your plan. (I did not put one together for the ping pong ball change since the costs and benefits there a probably quite small.) Please fax the sheets back as soon as you can.

I want to thank you for participating in the study. I found your responses informative and insightful. When I prepare my final report next month, I may call you via the telephone to clarify your responses or request further information. In the meantime, if you have any additional thoughts you would like to share with me, please call or fax my office.

Thank you once again for taking time out from you busy schedule to meet with me.

Sincerely,

Timothy J. Greiner, Principal
MBA, MCP, Certified Toxics Use Reduction Planner

Project Name: Nitric Acid Recovery System

Please complete the worksheet below. Call Tim Greiner @ 508-525-2214 if you have questions.

1. What were the main drivers for making the change? _____
   (e.g. $ savings, TURA, quality, throughput, meet TUR goals, other)

2. What were your main project resources? _____
   (workers, consultants, Eng., trade literature, other)

3. How many pounds per year of nitric/sulfuric/caustic/other did the project eliminate?
   nitric_____ sulfuric_____ caustic_____ other_____

4. Would you please quantify the following costs and benefits. .

$_____Capital Equipment Costs

$_____Raw Material Savings (e.g. acid or caustic savings, plating bath savings due to extended bath life)

$_____Waste Mgt. savings (e.g. pre-treatment, disposal, on-site handling, etc.)

$_____Utilities (e.g. electricity or steam, cooling & process water)

$_____Direct Labor Costs (e.g. operation labor, inspection (QA/QC) or worker productivity changes

$_____Regulatory Compliance Costs (e.g. monitoring, manifesting, record keeping, etc.)

$_____Other significant costs or savings from the project (please describe:
_____

5. Has the project had any of the following qualitative effects? Please check if significant:

_____employee health and safety _____throughput increase

_____employee morale/job satisfaction _____better knowledge of the process

_____relations with reg agencies _____improved corporate image

_____improved O & M _____relations between workers & management

Project Name: Hard Pipe Electroless Ni Tank to Nitric Storage Tank

Please complete the worksheet below. Call Tim Greiner @ 508-525-2214 if you have questions.

1. What were the main drivers for making the change? _____
   (e.g. $ savings, TURA, quality, throughput, meet TUR goals, other)

2. What were your main project resources? _____
   (workers, consultants, Eng., trade literature, other)

3. How many pounds per year of nitric/sulfuric/caustic/other did the project eliminate?
   nitric_____ sulfuric_____ caustic_____ other_____

4. Would you please quantify the following costs and benefits.

$_____Capital Equipment Costs

$_____Raw Material Savings (e.g. acid or caustic savings, plating bath savings due to extended bath life)

$_____Waste Mgt. savings (e.g. pre-treatment, disposal, on-site handling, etc.)

$_____Utilities (e.g. electricity or steam, cooling & process water)

$_____Direct Labor Costs (e.g. operation labor, inspection (QA/QC) or worker productivity changes

$_____Regulatory Compliance Costs (e.g. monitoring, manifesting, record keeping, etc.)

$_____Other significant costs or savings from the project (please describe:
_____

5. Has the project had any of the following qualitative effects? Please check if significant:

_____employee health and safety
_____employee morale/job satisfaction
_____relations with reg agencies
_____improved O & M
_____throughput increase
_____better knowledge of the process
_____improved corporate image
_____relations between workers & management

Appendix C: Net Present Value Analyses of TUR Plans and Projects

TUR Planning Case Study I: Plastic Extruder, Inc.

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Inflation Factor			1.000	1.050	1.103	1.158	1.216	1.276	1.340	1.407	1.477	1.551
OPERATING COSTS AND BENEFITS												
Plan Preparation		$ (18,509)										
Zinc Substitution Project			$ 24,938	$ 26,184	$ 27,494	$ 28,868	$ 30,312	$ 31,827	$ 33,419	$ 35,090	$ 36,844	$ 38,686
Operating Costs and Benefits		$ (18,509)	$ 24,938	$ 26,184	$ 27,494	$ 28,868	$ 30,312	$ 31,827	$ 33,419	$ 35,090	$ 36,844	$ 38,686
CASH FLOW ANALYSIS												
Net Cash Flow		$ (18,509)	$ 24,938	$ 26,184	$ 27,494	$ 28,868	$ 30,312	$ 31,827	$ 33,419	$ 35,090	$ 36,844	$ 38,686
-Depreciation												
Taxable Income		$ (18,509)	$ 24,938	$ 26,184	$ 27,494	$ 28,868	$ 30,312	$ 31,827	$ 33,419	$ 35,090	$ 36,844	$ 38,686
-Income Tax @ 40%		$ (7,404)	$ 9,975	$ 10,474	$ 10,997	$ 11,547	$ 12,125	$ 12,731	$ 13,367	$ 14,036	$ 14,738	$ 15,474
Net Income		$ (11,105)	$ 14,963	$ 15,711	$ 16,496	$ 17,321	$ 18,187	$ 19,096	$ 20,051	$ 21,054	$ 22,106	$ 23,212
+Depreciation												
After Tax Cash Flow		$ (11,105)	$ 14,963	$ 15,711	$ 16,496	$ 17,321	$ 18,187	$ 19,096	$ 20,051	$ 21,054	$ 22,106	$ 23,212

	Ten Year Period
NPV (in 1995 dollars)	$100,366

TUR Planning Case Study II: Automotive Supplier, Inc.

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Inflation Factor			1.000	1.050	1.103	1.158	1.216	1.276	1.340	1.407	1.477	1.551	1.629
OPERATING COSTS AND BENEFITS													
Plan Preparation Costs		$ (134,052)											
Chorine Project			$ 1,658	$ 1,741	$ 1,828	$ 1,920	$ 2,016	$ 2,116	$ 2,222	$ 2,333	$ 2,450	$ 2,572	
Zinc Compound Project		$ 55,347	$ 58,114	$ 61,020	$ 64,071	$ 67,275	$ 70,639	$ 74,170	$ 77,879	$ 81,773	$ 85,862		
Barium Project		$ 32,114	$ 33,720	$ 35,406	$ 37,176	$ 39,035	$ 40,987	$ 43,036	$ 45,188	$ 47,447	$ 49,820		
Zinc Sterate Project				$ 3,077	$ 3,230	$ 3,392	$ 3,561	$ 3,740	$ 3,926	$ 4,123	$ 4,329	$ 4,545	$ 4,773
Zinc Phosphate Project				$ 13,449	$ 14,122	$ 14,828	$ 15,569	$ 16,348	$ 17,165	$ 18,024	$ 18,925	$ 19,871	$ 20,865
Operating Costs and Benefits		$ 87,461	$ 93,493	$ 114,693	$ 120,428	$ 126,449	$ 132,772	$ 139,410	$ 146,381	$ 153,700	$ 161,385	$ 26,989	$ 25,637
CAPITAL COSTS													
Chorine Project		$ 91,000											
Zinc Compound Project	$ 23,000												
Barium Project	$ 23,000												
Zinc Sterate Project			$ 18,911										
Zinc Phosphate Project			$ 16,000										
Total Capital Expenditures	$ 46,000	$ 91,000	$ 34,911	$ -									
Cumulative Capital Expenditure		$ 46,000	$ 137,000	$ 171,911	$ 171,911	$ 171,911	$ 171,911	$ 171,911	$ 171,911	$ 171,911	$ 171,911	$ 125,911	$ 34,911
Depreciation (10 year straight-line)		$ 4,600	$ 13,700	$ 17,191	$ 17,191	$ 17,191	$ 17,191	$ 17,191	$ 17,191	$ 17,191	$ 17,191	$ 12,591	$ 3,491
CASH FLOW ANALYSIS													
Net Cash Flow	$ (46,000)	$ (3,539)	$ 58,582	$ 114,693	$ 120,428	$ 126,449	$ 132,772	$ 139,410	$ 146,381	$ 153,700	$ 161,385	$ 26,989	$ 25,637
-Depreciation	$ -	$ (4,600)	$ (13,700)	$ (17,191)	$ (17,191)	$ (17,191)	$ (17,191)	$ (17,191)	$ (17,191)	$ (17,191)	$ (17,191)	$ (12,591)	$ (3,491)
Taxable Income	$ (46,000)	$ (8,139)	$ 44,882	$ 97,502	$ 103,237	$ 109,258	$ 115,581	$ 122,219	$ 129,190	$ 136,509	$ 144,194	$ 14,398	$ 22,146
-Income Tax @ 40%	$ (18,400)	$ (3,255)	$ 17,953	$ 39,001	$ 41,295	$ 43,703	$ 46,232	$ 48,888	$ 51,676	$ 54,604	$ 57,677	$ 5,759	$ 8,858
Net Income	$ (27,600)	$ (4,883)	$ 26,929	$ 58,501	$ 61,942	$ 65,555	$ 69,348	$ 73,332	$ 77,514	$ 81,905	$ 86,516	$ 8,639	$ 13,288
+Depreciation	$ -	$ 4,600	$ 13,700	$ 17,191	$ 17,191	$ 17,191	$ 17,191	$ 17,191	$ 17,191	$ 17,191	$ 17,191	$ 12,591	$ 3,491
After Tax Cash Flow $ -	$ (27,600)	$ (283)	$ 40,629	$ 75,692	$ 79,133	$ 82,746	$ 86,539	$ 90,523	$ 94,705	$ 99,096	$ 103,707	$ 21,230	$ 16,779

	Ten Year Period
NPV (in 1995 dollars)	$449,367

Technical Assistance Case Study I: Paper Converter, Inc.

Year		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Inflation Factor			1.000	1.050	1.103	1.158	1.216	1.276	1.340	1.407	1.477	1.551
OPERATING COSTS AND BENEFITS												
Avoided Wastewater Treatment Plant Chemical Costs			$ 30,000	$ 31,500	$ 33,075	$ 34,729	$ 36,465	$ 38,288	$ 40,203	$ 42,213	$ 44,324	$ 46,540
Avoided Treatment Plant Waste Disposal			$ 26,250	$ 26,250	$ 26,250	$ 26,250	$ 26,250	$ 26,250	$ 26,250	$ 26,250	$ 26,250	$ 26,250
OTA Consulting			$ 1,200	$ -								
Increased raw material costs			$ (100,000)	$ (60,000)	$ (20,000)	$ (20,000)	$ -	$ -	$ -	$ -	$ -	$ -
Avoided Testing			$ 500	$ -								
Avoided Wastewater Operator Training & Certification			$ 4,694	$ 4,928	$ 5,175	$ 5,433	$ 5,705	$ 5,990	$ 6,290	$ 6,604	$ 6,935	$ 7,281
Avoided Wastewater Treatment Plant Labor Costs			$ 14,668	$ 14,668	$ 14,668	$ 14,668	$ 14,668	$ 14,668	$ 14,668	$ 14,668	$ 14,668	$ 14,668
Water Conservation Cost Savings			$ 58,086	$ 60,990	$ 64,040	$ 67,242	$ 70,604	$ 74,134	$ 77,841	$ 81,733	$ 85,819	$ 90,110
Total Operating Costs and Benefits			$ 35,397	$ 78,336	$ 123,207	$ 128,321	$ 153,692	$ 159,330	$ 165,251	$ 171,468	$ 177,995	$ 184,849
CAPITAL COSTS												
Water Conservation Equipment (valves, piping, labor)		$ (100,000)										
Avoided waste water treatment plant construction		$ 375,000										
Total Capital Costs		$ 275,000										
Depreciation (10 yr straight-line)			$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500
CASH FLOW ANALYSIS												
Capital Costs		$ 275,000										
Operating savings		$ -	$ 35,397	$ 78,336	$ 123,207	$ 128,321	$ 153,692	$ 159,330	$ 165,251	$ 171,468	$ 177,995	$ 184,849
-Depreciation		$ -	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500
Taxable Income		$ 275,000	$ 62,897	$ 105,836	$ 150,707	$ 155,821	$ 181,192	$ 186,830	$ 192,751	$ 198,968	$ 205,495	$ 212,349
-Income Tax @ 40%		$ 110,000	$ 25,159	$ 42,334	$ 60,283	$ 62,329	$ 72,477	$ 74,732	$ 77,100	$ 79,587	$ 82,198	$ 84,940
Net Income		$ 165,000	$ 37,738	$ 63,502	$ 90,424	$ 93,493	$ 108,715	$ 112,098	$ 115,651	$ 119,381	$ 123,297	$ 127,409
+Depreciation		$ -	$ (27,500)	$ (27,500)	$ (27,500)	$ (27,500)	$ (27,500)	$ (27,500)	$ (27,500)	$ (27,500)	$ (27,500)	$ (27,500)
After Tax Cash Flow	0	$ 165,000	$ 10,238	$ 36,002	$ 62,924	$ 65,993	$ 81,215	$ 84,598	$ 88,151	$ 91,881	$ 95,797	$ 99,909

	Ten Year Period
NPV (in 1995 dollars)	$584,876

Technical Assistance Case Study II: Metal Manufacturer, Inc.

Year		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Inflation Factor			1.000	1.050	1.103	1.158	1.216	1.276	1.340	1.407	1.477	1.551
OPERATING COSTS AND BENEFITS												
Avoided Use of Consultants		$ 9,000										
Avoided Labor Cost to Operate Treatment System			$ 8,000	$ 8,400	$ 8,820	$ 9,261	$ 9,724	$ 10,210	$ 10,721	$ 11,257	$ 11,820	$ 12,411
Annual Wastewater Treatment Training Costs			$ 500	$ 525	$ 551	$ 579	$ 608	$ 638	$ 670	$ 704	$ 739	$ 776
Avoided Permit Fees			$ 1,500									
Avoided Chemical Meter Purchase			$ 2,000									
Avoided Tank and Pump Purchase			$ 3,000									
Avoided Chemical Neutralization Costs			$ 1,000	$ 1,050	$ 1,103	$ 1,158	$ 1,216	$ 1,276	$ 1,340	$ 1,407	$ 1,477	$ 1,551
Filter Cost			$ (1,500)	$ (1,575)	$ (1,654)	$ (1,736)	$ (1,823)	$ (1,914)	$ (2,010)	$ (2,111)	$ (2,216)	$ (2,327)
Water Reduction Cost Savings			$ 1,000	$ 1,050	$ 1,103	$ 1,158	$ 1,216	$ 1,276	$ 1,340	$ 1,407	$ 1,477	$ 1,551
Phosphating Chemical Cost Savings			$ 750	$ 788	$ 827	$ 868	$ 912	$ 957	$ 1,005	$ 1,055	$ 1,108	$ 1,163
Operating Costs and Benefits	$ -	$ 9,000	$ 16,250	$ 10,238	$ 10,749	$ 11,287	$ 11,851	$ 12,444	$ 13,066	$ 13,719	$ 14,405	$ 15,125
CAPITAL COSTS												
Water Conservation Equipment (valves, piping, labor)		$ 13,500										
Total Capital Costs		$ 13,500										
Depreciation (10 yr straight-line)			$ 1,350	$ 1,350	$ 1,350	$ 1,350	$ 1,350	$ 1,350	$ 1,350	$ 1,350	$ 1,350	$ 1,350
CASH FLOW ANALYSIS												
Capital Costs		$ (13,500)										
Operating savings		$ -	$ 9,000	$ 16,250	$ 10,238	$ 10,749	$ 11,287	$ 11,851	$ 12,444	$ 13,066	$ 13,719	$ 14,405
-Depreciation		$ -	$ (1,350)	$ (1,350)	$ (1,350)	$ (1,350)	$ (1,350)	$ (1,350)	$ (1,350)	$ (1,350)	$ (1,350)	$ (1,350)
Taxable Income		$ (13,500)	$ 7,650	$ 14,900	$ 8,888	$ 9,399	$ 9,937	$ 10,501	$ 11,094	$ 11,716	$ 12,369	$ 13,055
-Income Tax @ 40%		$ (5,400)	$ 3,060	$ 5,960	$ 3,555	$ 3,760	$ 3,975	$ 4,200	$ 4,437	$ 4,686	$ 4,948	$ 5,222
Net Income		$ (8,100)	$ 4,590	$ 8,940	$ 5,333	$ 5,640	$ 5,962	$ 6,301	$ 6,656	$ 7,030	$ 7,422	$ 7,833
+Depreciation		$ -	$ 1,350	$ 1,350	$ 1,350	$ 1,350	$ 1,350	$ 1,350	$ 1,350	$ 1,350	$ 1,350	$ 1,350
After Tax Cash Flow	0	$ (8,100)	$ 5,940	$ 10,290	$ 6,683	$ 6,990	$ 7,312	$ 7,651	$ 8,006	$ 8,380	$ 8,772	$ 9,183

	Ten Year Period
NPV (in 1995 dollars)	$40,047